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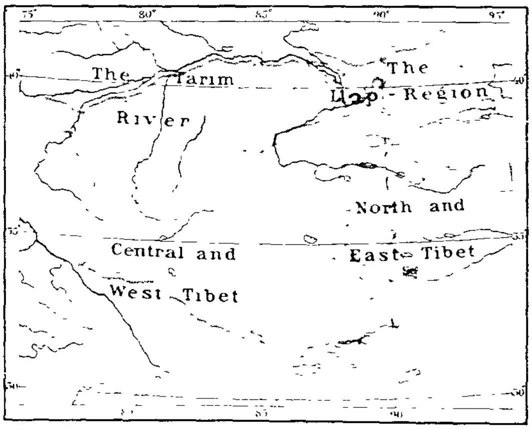
SVEN HEDIN

# SCIENTIFIC RESULTS
# OF A JOURNEY IN
# CENTRAL ASIA
# 1899—1902

## VOL. II
## LOP-NOR

BY

DR SVEN HEDIN



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# CONTENTS.

## THE KURUK-TAGH AND THE KURUK-DARJA.

Page
Chapter I. From the Kontsche-darja to the foot of the Kuruk-tagh . . . . . . . . 3.
II. The Kuruk-tagh and Jing-pen . . . . . . . . . . . . . . . 19.
III. The Kuruk-darja and the country south of the Kuruk-tagh . . . . . . . 43.
IV. Across the Jardang desert to Altmisch-bulak . . . . . . . . . . . . . 58.
V. Grum-Grschimajlo's journey across the mountains north of Kuruk-tagh . . 74.
VI. Kosloff on the western Kuruk-tagh . . . . . . . . . . . . . . . . . . . 85.
VII. Roborovskij, Prschevalskij and Futterer on the Kuruk-tagh . . . . . . . 93.
VIII. The author's own journey in the Kuruk-tagh . . . . . . . . . . . . . 104.

## KARA-KOSCHUN.

Chapter IX. The waters to the north of the Kara-koschun . . . . . . . . . . . 125.
X. North and south waterways of the Kara-koschun . . . . . . . . . . . . 135.
XI. Volumes of the Tarim, Jurt-tschapghan and Kum-tschapghan . . . . . . 151.
XII. A newly discovered lake north of Kara-koschun. — Eastern and southern shores of Kara-koschun . . . . . . . . . . . . . . . . . . . . . . . 165.
XIII. The waters on the north of the Kara-koschun . . . . . . . . . . . . . 177.
XIV. Hydrographical relations on the north of the Kara-koschun . . . . . . 191.
XV. General conclusions regarding the Kara-koschun . . . . . . . . . . . 203.

## THE DESERT OF LOP.

Chapter XVI. Across the desert from Altmisch-bulak . . . . . . . . . . . . . . . 221.
XVII. Surveying the desert . . . . . . . . . . . . . . . . . . . . . . . . 234.

## THE LOP-NOR PROBLEM.

Chapter XVIII. The Lop-nor problem. — Richthofen and Prschevalskij . . . . . . . . . 257.
XIX. The Lop-nor — Kosloff and the author . . . . . . . . . . . . . . . . 268.
XX. The Lop-nor region on the Wu-tschang-fu map . . . . . . . . . . . . 281.
XXI. Author's reply to Kosloff's criticisms. Krapotkin, Grenard . . . . . . . 298.
XXII. Analysis of author's survey of the desert . . . . . . . . . . . . . . . 314.
XXIII. General hydrographical relations of the Tarim deltaic region . . . . . . 330.
XXIV. Factors tending to decrease the volume of the Tarim — Migrations of the Lop-nor . . . . . . . . . . . . . . . . . . . . . . . . . . . . 353.
XXV. Comparison between the Tarim and other Central Asian basins . . . . . 369.

## THE CENTRAL ASIAN DESERTS, SAND-DUNES, AND SANDS.

Page
Chapter XXVI. The deserts of Ordos, Kum-tagh, Kaschgaria, and Ak-bel-kum . . . . 379.
XXVII. Altitude of dunes, movements of dune-masses . . . . . . . . . . . . 396.
XXVIII. Ripple-marks; origin of dunes; wave-movements . . . . . . . . . . . . 410.
XXIX. Sand-currents — ripple-marks, waves, and dunes . . . . . . . . . . . 426.
XXX. Origin of sand in the Tarim basin: disintegration products . . . . . . 441.
XXXI. Origin of sand in the Tarim basin: alluvial sand and already existent marine sand . . . . . . . . . . . . . . . . . . . . . . . . . 452.
XXXII. Specimens of sand, dust, and mud . . . . . . . . . . . . . . . . . 462.
XXXIII. From the Anambaruin-gol to the desert-range . . . . . . . . . . . . 471.
XXXIV. From the desert ranges to the Kuruk-tagh . . . . . . . . . . . . . . 484.

## GENERAL HYDROGRAPHY OF THE TARIM SYSTEM.

Chapter XXXV. Tschernoff's expedition . . . . . . . . . . . . . . . . . . . . . . . . 503.
XXXVI. General hydrographical relations of the Tarim-basin . . . . . . . . . 515.
XXXVII. Characteristics of the Tarim to Karaul . . . . . . . . . . . . . . 529.
XXXVIII. High-water periods. — The Tarim from Karaul to Kara-koschun . . . . 541.
XXXIX. River and lake statistics . . . . . . . . . . . . . . . . . . . . . . 553.

## THE HYPSOMETRICAL RELATIONS OF THE TARIM BASIN.

Chapter XL. Contour-lines of the upper Tarim basin . . . . . . . . . . . . . . . . 565.
XLI. Hypsometrical relations of lower Tarim basin and of Kuruk-darja . . . 576.
XLII. Methods of calculating the altitudes above sea-level, by Dr. N. Ekholm . 585.
Table 1. The Tarim river from Lajlik to Jangi-köl . . . . . . . . . . 588.
Table 2. The Tarim river (western branch) from Jangi-köl to Kum-tschapghan . . . . . . . . . . . . . . . . . . . . . . . . . . . 592.
Table 3. The Tarim river (western branch) from Jangi-köl to Kum-tschapghan . . . . . . . . . . . . . . . . . . . . . . . . . . . 593.
Table 4. The Tarim river (eastern branch) from Tokus-tarim to Jangi-köl 594.
Table 5. The Tarim delta, environs of Kara-koschun . . . . . . . . . 594.
Table 6. Tarim river (eastern branch) from Tokus-tarim to Kepek-uj . 596.

## POPULATION OF EAST TURKESTAN.

Chapter XLIII. Population of East Turkestan . . . . . . . . . . . . . . . . . . . . 599.

## THE RUINS OF LÔU-LAN.

Chapter XLIV. The ruined houses of Lôu-lan . . . . . . . . . . . . . . . . . . . 619.
XLV. Towers, wood-carvings etc. of Lôu-lan . . . . . . . . . . . . . . . . 637.
XLVI. Transcription of geographical names in Central Asia. By Dr. K. B. Wiklund 647.
Geographical names.—List of abbreviations . . . . . . . . . . . . . . 661.

# THE KURUK-TAGH AND THE KURUK-DARJA

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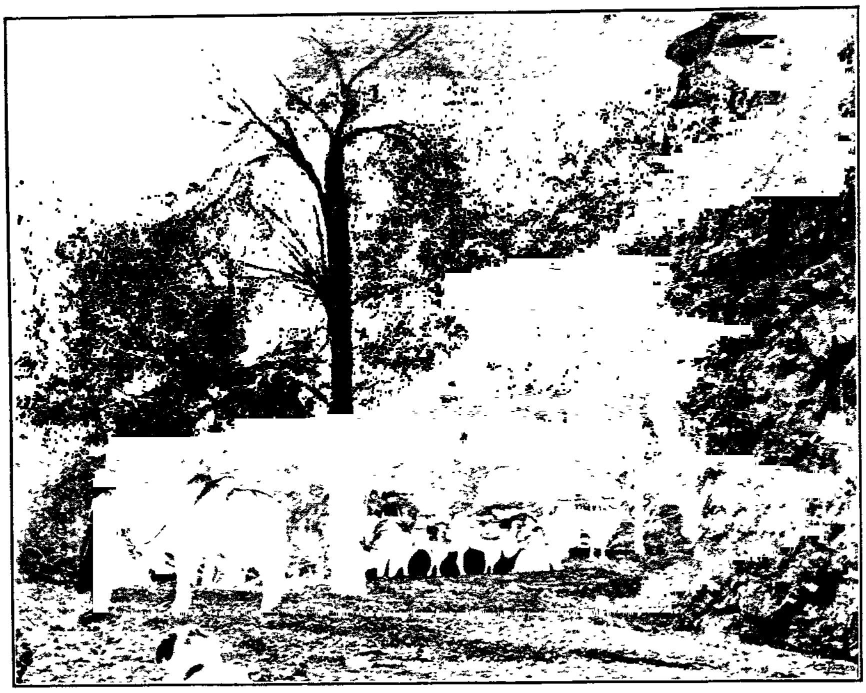

Fig. 1. THE TOGHRAK-BULAK OR ASTIN-BULAK.

# CHAPTER I.

## FROM THE KONTSCHE-DARJA TO THE FOOT OF THE KURUK-TAGH.

I started for my first excursion to the Desert of Lop on the 5th March 1900. My principal object was to investigate and map the old dried-up river-bed, the beginning of which I had observed starting from the Kontsche-darja in 1896,* and the continuation of which towards the east was confirmed by Kosloff at two points during the Russian expedition of 1893—95, under the leadership of Roborovskij. To the river-bed which he noted Kosloff gave the name of Kum-darja, or the Sand River: he regarded it as an older channel of the Kontsche-darja. His acquaintance with the districts south of the Kuruk-tagh was only fugitive, it is true, still the information he gave regarding them was so important, and so interesting, that it led me to think the region would be worth a more searching exploration, and in especial that an accurate mapping of the Kum-darja could not fail to contribute towards the solution of the Lop-nor problem. Perhaps by following this old river-bed eastwards one might discover the former lake of Lop-nor, which was long known to the Chinese, and the former existence of which in this part of Asia was demonstrated by Baron von Richthofen in a brilliant way to be a necessity both on historical and on geological grounds.

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* See my map in *Petermanns Mitteilungen*, Ergänzhft. 131.

In the account* of his journey Kosloff writes thus regarding the Kum-darja: »After travelling about 25 versts from Altmisch-bulak, we at length reached the bed of the Kum-darja. It extends from west to east, along the southern foot of the Kuruk-tagh. In some places it is choked with coarse-grained sand, in others it is perfectly open, allowing us to form some conception of its dimensions and character. This trough-like depression is 15 to 25 saschen wide; now runs almost straight, now serpentines; and its bottom consists of saline ground as hard as stone. The banks are in some places high, in others low. Occasionally the depression is choked with a layer of gravel fully a foot thick, and is joined by many similar dry torrents from the north.

Dead trees (poplars) lie scattered about in the deeper parts. Animal life is entirely absent: we saw no other signs except old traces of a stray antelope and the dried up skeleton of a buzzard (*Buteo*). For as far as we were able to see with the glass to the south-south-east there appeared several similar terraces, apparently river-terraces, which probably belonged to branches of the old river. My guide crossed other similar terraces to the south of the spring of Jardang-bulak whilst on his way from Kisil-sinir to the Kontsche-darja. But he saw no hills of drift-sand along that route; nor did I see any either at the place where I struck the Kum-darja.

After glancing in this way at a long stretch of the Kum-darja, we turned towards the north-west.»

With regard to the point higher up in the same bed, where Kosloff crossed it somewhat later, he only says, that the river-bed there was »dead», and had a forlorn look, and that the banks, which were not yet obliterated, were in part high, in part low. Ancient and dead poplar-trees lay scattered throughout this old river-bed, and many others were still standing upright.**

Scanty though this information is, it is nevertheless quite sufficient to establish the existence of an ancient river-bed, on the banks of which forest formerly grew. Our knowledge was thus restricted to three points of the Kum-darja, separated from one another by considerable distances; but of these intermediate distances, as of the point where the old watercourse ended, we knew nothing. This then was what I set myself to find out. By a pure chance I happened to meet with the camel-hunter Abdu Rehim of Singer (Kosloff's Kisil-sinir), who took part in Kosloff's expedition from which I have just quoted. This man was one of the few natives who knew where the spring of Altmisch-bulak is situated, for it was absolutely necessary to make that spring the base for further investigations in the desert to the south.

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* *Trudij Ekspeditsij Imp. Russ. Geogr. obschtschestva po Tsentralnoj Asij, 1893—95*, vol. II. p. 67.

** *Op. cit.*, p. 74.

I set out from my headquarters camp at Jangi-köl on 5th March, taking with me a flying caravan of a few camels and men, and one horse. This excursion and the geographical discoveries it led to I will now proceed to describe, referring to my previous book, *Central Asia and Tibet*, for an account of the equipment of the caravan.

Fig. 2. AT DILPAR.

At first our route led towards the north-north-west, across steppe whereon grew a few toghraks. Then we rode through the village of Ak-tarma, reported then to consist of 7 ujlik, the bek's ujlik containing 40 persons, the others 4 to 5 each. Thence a path runs to Tägirmän, on the great highway, a place of 4 to 5 ujlik. Beyond Ak-tarma we soon passed, on the right, the village of Dschan Kulu (also pronounced Dschan Kuli), consisting of several huts and homesteads, all deserted. Its former inhabitants were Tungans, who subsequently flitted to Kara-kum near Schin-algha. A bridge led across the Jaman-ilek, the river-arm already mentioned. It was here very deep, and flowed at the bottom of a deeply trenched bed, though at the time we crossed it it was ice-bound. The current is said however never to be very great. On the left we then passed Dschan Kuli-örtäng, or the Station of Dschan Kuli, situated on the great highway between Korla, Dural, and Tscharklik. Just at the point where we bisected this road at right angles there is a mill. On the right we had next a miniature oblong lake, covered with ice; evidently it occupies the site of a former river-bed, and it is hemmed in by kamisch all round. Shortly after that we crossed over a pretty big boldschemal filled with ice-bound water. According to one of my older guides, this river-bed, known as the Kona-tägirmän, was formerly the main artery of the Tarim. It is stated to begin at Aghis (Kitaj-köbrük), and farther on to unite with the Jaman-ilek. The water it then contained was said to come from an artificial canal, likewise starting at Aghis.

After that the country becomes more desolate and bare; it consists of steppe with *tschige* and tamarisks, while on the left is a belt of barren sand. Farther on is low sand on both sides of the track, and scattered about the sparse steppe are numerous dead tamarisks on their mounds. The track was now running towards the north-north-east and the north-east. At Käräliк we traversed the bottom of a former lake, the greater part of its area lying on our right. It had evidently been fed by a stream of considerable size, for we saw its course quite distinctly marked, though of course without water. This too is said to have started at Aghis, but to have joined the Kontsche-darja at Ak-basch. It has been dry for the last ten years, having been dammed because it robbed the main stream of too much water, and was threatening to drown some pasture-lands lower down. Here too tamarisks, both living and dead, are pretty numerous, some of them with, others without, the usual conical pedestals of earth. Then thin scrubby steppe alternated with low sand and *schor*, or saliferous soil, until we at length came in sight of the poplar forest that grows beside the Kontsche-darja. This district is called Dilpar. On the right of the river lies a shallow lake, or rather a marsh, which derives its water from the river; it is said to be *sollak-su*, or »stagnant water» — a small marginal lake in miniature. Dense and luxuriant kamisch steppe lies all round its shores, and indeed extends generally along the right bank of the river; here we perceived several *aghils*, or »sheep-folds», together with shepherds and their flocks.

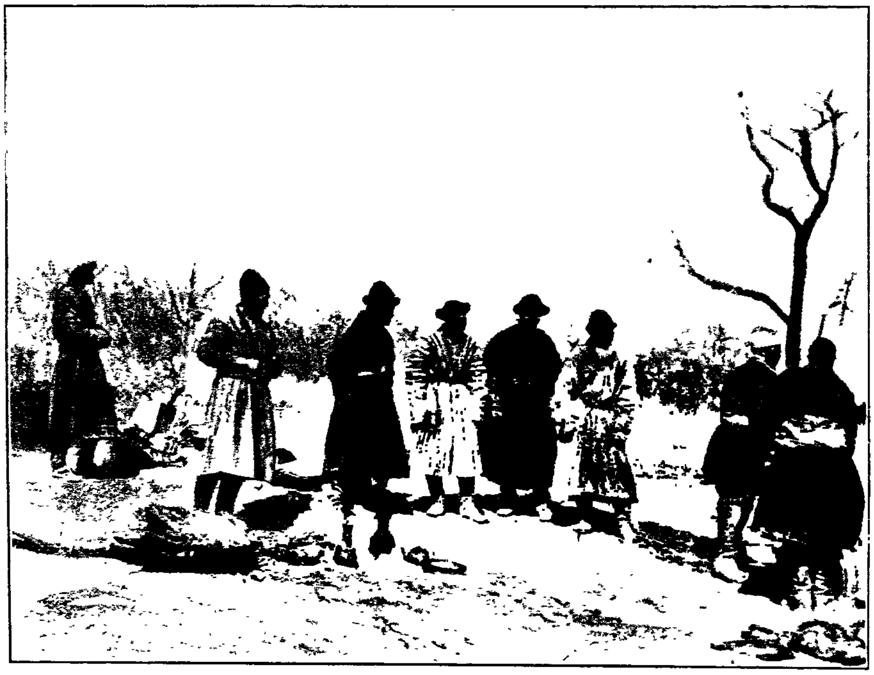


Fig. 3. ANOTHER VIEW OF DILPAR.

The right bank is low and level. The left bank, on the contrary, is high, and it is only upon it, at all events it is so at Dilpar, that the poplar woods grow; though both higher up and lower down there are reported to be toghrak forests on the right bank as well. Hence the relation here is the reverse of that which we found to obtain in the case of the Tarim; for, whereas it is the right bank of the latter that runs next the desert, the Kontsche-darja has the desert on its left bank. South-west of the Tarim we found the country low and plentifully indented with depressions; but in the case of the Kontsche-darja it is the north-east, or outer, bank that is higher. This circumstance apparently contradicts the proposition I have already laid down (vol. I p. 302), namely that the inter-riverine tract between the Kontsche and the Tarim forms, in relation to the adjacent desert, a sort of low terrace, or in other words, that

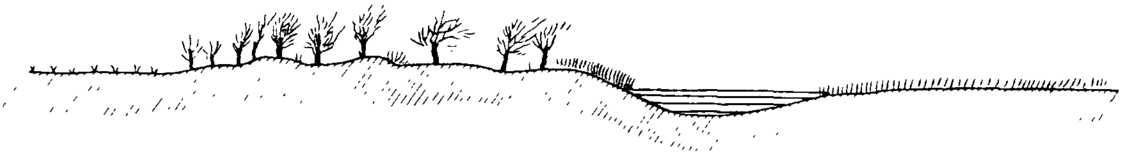
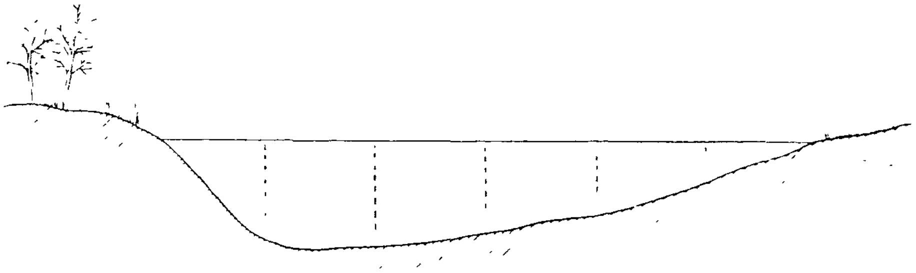


Fig. 4. VERTICAL SECTION OF THE KONTSCHE-DARJA. THE LEFT BANK IS HIGH, THE RIGHT LOW.

Fig. 5. FOREST AT DILPAR.

the part of the country in which vegetation thrives has been elevated owing to the drift-sand and dust lodging against the roots of the plants, and thus in course of time gradually raising the dry-land level. But even the strip of »shore» along the left bank of the Kontsche-darja forms an exception to this, for it forms a sort of rather narrow rampart, elevated a few meters above the level of the stream. The river constitutes, as I proved after my journey of 1896, a boundary-line beyond which the drift-sand and the dunes do not advance towards the west. Of the sand which does pile itself up on the left bank, some gets washed away by the river, some settles in the forest, which thus detains it and brings its journeying to a standstill, so that the rampart I have spoken of becomes raised higher as the years go past. And yet the law to which I have alluded above, namely that the belt of vegetation is the higher ground, is not inoperative; for one, or it may be two kilometers north-east of the Kontsche-darja the desert does undoubtedly lie lower than the inter-riverine-tract.



| | | | | | | |
|---|---|---|---|---|---|---|
| Fig. 6. Left. | 5.62 | 5.92 | 5.01 | 4.05 | 2.03 = depth. | |
| | 0.50 | 0.32 | 0.29 | 0.45 | 0.60 = thickness of ice. | |
| | 40 | 43 | 40 | 34 | 0 | velocity. |
| | 27 | 44 | 41 | 40 | 0 | |
| | 29 | 49 | 42 | 36 | | |
| | 28 | 42 | 44 | 0 | | |
| | 10 | 29 | 0 | | | |
| | | 0 | | | | |

Breadth = 36.0 m; Kontsche-darja at Dilpar; March 6; Scale = 1 : 400.

The toghrak forest on the left bank is well advanced in age. True, the trees are neither so magnificently grown, nor yet so old as the poplars beside the Tschertschen-darja and at At-jegen (vol. I, p. 423); still they are considerably past their prime. On the Jarkent-darja, south of Dilpar, the oldest poplars do not exceed 50 years, and are extremely sparse and rare. Beside the Jaman-ilek the forest is more plentiful as well as older; but when we get to the Kontsche-darja the trees grow thickly together and are relatively old. Whence we are justified in concluding that the Kontsche is the oldest stream of the three.

The shape and dimensions of the river-bed at Dilpar on the 6th March are shown in the accompanying section: breadth, 36.0 m.; mean depth, 3.405 m.; maximum depth, 5.92 m.; mean velocity, 0.2667 m.; and volume, 32.70 cub.m. in the second. On the 2nd of March the Tarim had a volume of 41.78 cub.m. Thus the difference in volume between the two rivers is not at this season particularly great; or, what amounts to the same thing, the difference between maximum and minimum volume is much less in the case of the Kontsche-darja than in the case of the Tarim. At any rate the amount of water in the Kontsche-darja was unexpectedly small, when one considers that the river at Korla carries constantly, winter and summer alike, a volume of 72 cub.m. per second, and that, as the natives asserted, most of the canals were not as yet opened. The ice covering too appeared to show that no drain had been made upon the river recently for irrigating the spring-seed, for it was level and smooth, and not saucer-shaped, as it would have been, had the volume begun to diminish in the way I found it in March 1896. The volume appeared in fact to be about the same that it was in the beginning of winter, when the river began to freeze. Indeed I was assured that the level at Dilpar was at its highest, and that, as soon as the canals were opened, as they would be shortly, it would drop very appreciably. All the same the volume of 32.70 cub.m. does agree sufficiently well with the measurements (vol. I chapter XXX) of the Kontsche-darja already made, namely 19 cub.m. for all the arms that empty into the Kuntschekisch-tarim, and 13.22 cub.m. for the Bos-ilek, which empties into the Avullu-köl, or a total of 33.22 cub.m. in all. Thus along this fairly long stretch the river would appear to have lost less than one cub.m. of water. Hence it is all the stranger to find that in the interval between Korla and Dilpar, which is very little shorter, the river should lose more than one-half of its entire volume. This is probably in no small degree due to

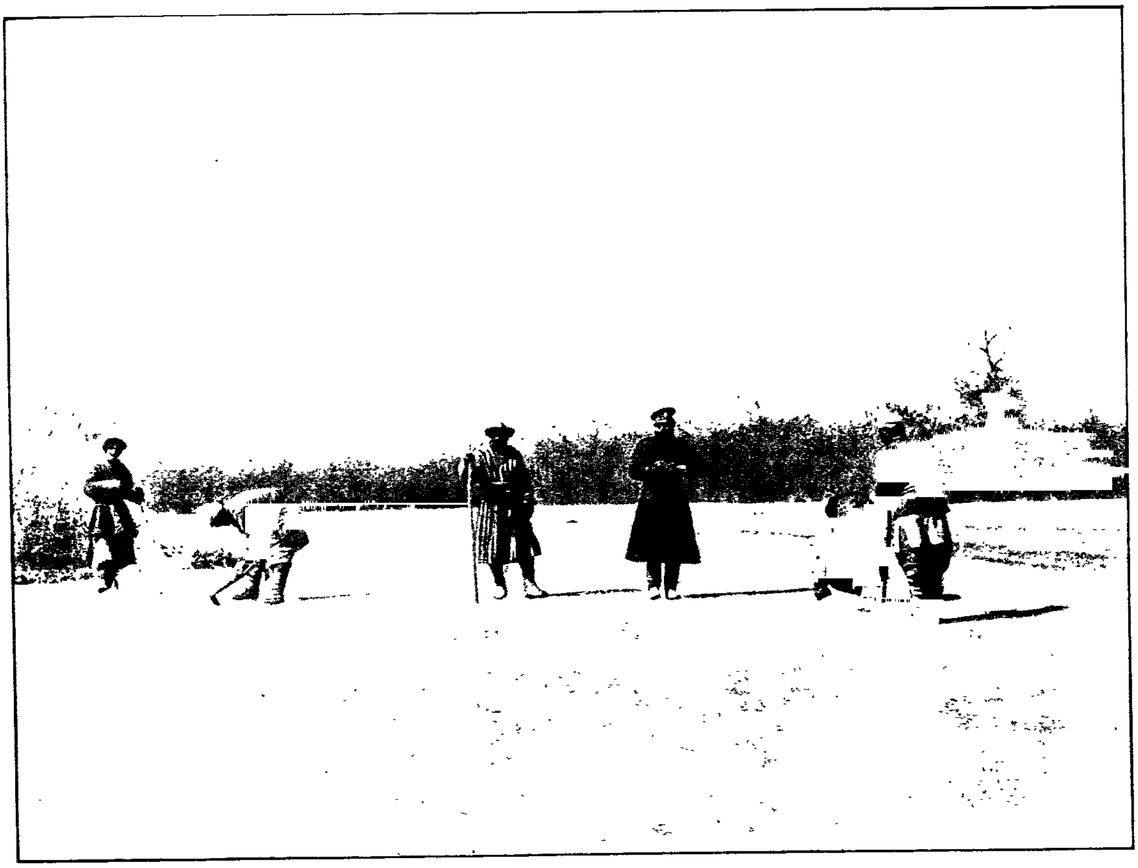


Fig. 7. MEASURING THE KONTSCHE-DARJA THROUGH HOLES IN THE ICE.

the amount of water which becomes locked up in the form of ice. From this we may conclude that there must also be a spring-flood (*mus-suji*) in the Kontsche-darja, also caused as usual by the thawing of the ice. Possibly however this is to some extent neutralised by the great quantities of water that are drained away for irrigation from the end of March onwards. The natives tell me, that the ice generally breaks up between the 20th and 25th of March, and that as soon as the spring-flood (the thawed ice-water) has gone past, the river drops rapidly. It may therefore be taken for granted, that not only the Bos-ilek, but also all the emissaries of the Kontsche-darja which go to join the Kuntschekisch-tarim, sink to a low ebb. The Bos-ilek however does not appear to die away entirely in the summer, as, for example, the Chotan-darja does; for if it did, the sandy desert would be able, at all events during that season of the year, to continue its migration towards the west; and yet this does not appear to be the case. But the elucidation of these points must be reserved for the future.

Generally speaking, the ice-sheet on the Kontsche-darja was thinner than that four days before on the Tarim. The toplayer was to the depth of 3 cm. soft, slushy, and rotten, and saturated with water, so that even before the holes were chopped right through the ice-sheet, they became full of water. Lower down in sheltered places the ice was still bright and hard. The water was as clear as crystal, transparent to the depth of 2.28 m., and had a temperature of + 0.2° C. in the holes we chopped in it.

The following information which I gleaned here is interesting. It is about two generations ago since the Intschkä-darja reunited with the Kontsche-darja, yet not in the way usually shown on our maps: for, instead of proceeding due east from Tschong-köl, it travelled by two arms, and towards the south-east. From the lake just mentioned, it made its way to the lake of Kara-ghatik-köl, where it divided into two branches, of which one, that on the left or north, emptied into the Kontsche-darja in the district of Jardang, and the other, on the right, joined the same stream at Dilpar. During the period that the Kontsche-darja flowed east through the bed of the Kum-darja (which Kosloff discovered), the Tarim, as I have already stated, was united with it, for I shall prove lower down that the Kontsche alone would not have been able to excavate such a large channel as the Kum-darja now is. Perhaps the Tarim at that time proceeded due east through the above-mentioned mouths of the Intschkä-darja, picking up on its way the Kontsche-darja; for this was then, as it is now, only a tributary of the main stream.

The following, I was told, are the names of the forest-tracts as one advances up the river (r. = right; l. = left): Dilpar (r.); Kalmak-tüschdi (l.); Aruk-baliklik or Aruk-balik-jarsik (l.); Tschajlik (l.) and Jardang (r.); Schaldschalik (r.); Ak-ördäk-daschi (l.); Arpalik (r.); Saj-tscheke (l.); Oro-tscheke (r.); Buja-tscheke (r.); Dung-otak (r.); Kasuk-akti (r.); Gerilghan (l.). The following names were known to my guides as belonging to the lower part of the Kontsche-darja: Dötö (r.); Tugha-baschi (r.); Salini-söresu; Aruk-balik (l.); Katschkan-uj (r.); Jäkänlik (l ); Ak-basch-kijak (r.); Tokus-tolluk (r.); Mane or Majni (l.); Kurlik-uj or Kurlalik-uji (r.); Jäti-jaghatsch; Kalpuk-utschugho (l.); Toghri-darja or Toghoro-darja (r.); Kongurtschak-tscheke (l.); Katschip-ulturghan; Masar (r.); Tschapghan-köl (l.); Sopu Nias; Tscharuk-asti (l.);

Kum-tscheke (r.); Darghalik (l.); Tschapal (l.); Kasan-sindi (l.); Schirdak-uji (l.); Arsu Beki-dschajiri, Turfan-karaul, Basch-toghrak, and Toghri-köl.

From Dilpar three routes lead to Jing-pen: (1) Alongside the river, through forest, round the north-going windings as far as Turfan-karaul, and thence along the usual Turfan road. (2) Across the barren desert, first north as far as Kalta, and thence straight to Jing-pen. This route appears to follow the old bed of the Kontsche-darja, though there is of course no water in it. Beside it there are reported to be two or three old *toras*, or *potajs*, i. e. pyramidal »mile«-posts, which evidently mark the ancient road from Lop-nor to Korla. This road, the northern prolongation of which I discovered in 1896, ran in its time along the left or northen bank of the united river (Tarim + Kontsche), and then, after the confluence, on the left bank of the Kontsche-darja. (3) The great winding road along the southern foot of the Kuruk-tagh, which I shall briefly describe in the following pages. None of these routes is of any importance: they are seldom used, and then only by hunters, or very exceptionally by a chance merchant going to Turfan.

The distance between Jangi-köl and Dilpar is 31.6 km. Thus the tract between the two rivers is here pretty broad, and as water is extremely scarce, the Jaman-ilek being the only stream, the vegetation also is excessively poor. Unless the river shifts its bed again, or unless a fresh bifurcation takes place, this strip of land will gradually assume the character of desert.

Almost the same distance, that is to say, 32.7 km., separated us on 7th May from Suget-bulak, which lies N. 28.3° E of Dilpar. Our route therefore ran at right angles to the river, leading through the toghrak forest of Dilpar, in which, strange to say, several of these fine trees are dead. The biggest stand just on the outskirts of the forest, where it yields to the steppe of scrubby *jantak* and tamarisks. There is another narrow belt of withered poplars crowning a terraced elevation, parallel to the river, and bordered on the north by an old winding river-bed, the course of which is plainly indicated. On the left bank of the old river-bed there still remain three huts, consisting of poles driven vertically into the ground, and surrounded by *kötäk*, or »dead trees«. A few hundred meters farther on we crossed yet another similar river-bed, it too running parallel to the Kontsche-darja. This again is distinctly outlined, being deeply sunk in the ground; it also has kötäk on its northern bank. The natives have a tradition that several *decennia* ago the Kontsche-darja for a long time used to oscillate between these two river-beds, and showed considerable irresolution before it finally settled down into its existing channel. It is probable that the old desiccated course I discovered at Kalta in 1896 is a continuation of the two river-beds in question; at any rate these last undoubtedly mark the last stage but one in the successive south-westward migrations of the Kum-darja.

Next comes thin tamarisk steppe, sparsely dotted with mounds or else without them. The soil consists of white crystalline, tolerably hard *schor*, which crackled under our feet, although it was overlain by a thin layer of sand. After that we crossed a narrow zone of *jardangs*, that is hard, dry clay terraces, sculptured at the bottom of some natural watercourse, in which wind erosion played an active part. The region was almost entirely barren; occasionally we caught sight of a withered tamarisk, seldom of a living one. A third watercourse, not quite so dis-

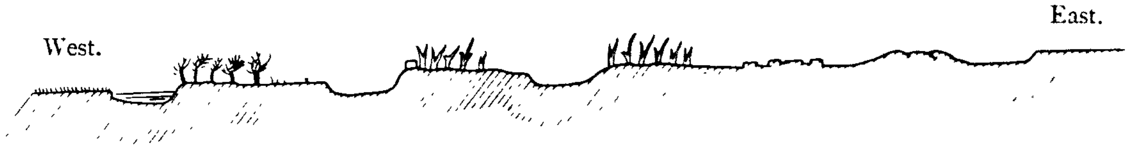


Fig. 8. THE MIGRATIONS OF THE KONTSCHE-DARJA.

tinctly marked as the other two, had on its right or southern bank a belt of rudimentary dunes, barely half a meter high; these too were on saline soil. This third watercourse also ran parallel to the Kontsche-darja, being in fact a former bed of that stream, though in virtue of its greater age it was more obliterated. Contrary however to the other two, it possesses no forest on its left bank. In the case of the other two watercourses the attention is at once arrested by the fact that the dead forest stands, as it does in the case of the Kontsche-darja, on the left bank only, that is to say on the bank away from which the river is travelling. In the Kontsche-darja the right bank is the one against which the pressure of the water is strongest, and consequently it is the one in the greater danger, and here it is that forest is wanting. There can be no doubt therefore that this arrangement of the forest is intimately connected with the migration of the river towards the right. The Kum-darja, with which we shall presently become better acquainted, affords the most luminous demonstration of the variability of the hydrography of the Lop country; similarly in these three dry watercourses we have a brilliant proof that the movement is still going on. In the first vol. we have ascertained that the Tarim

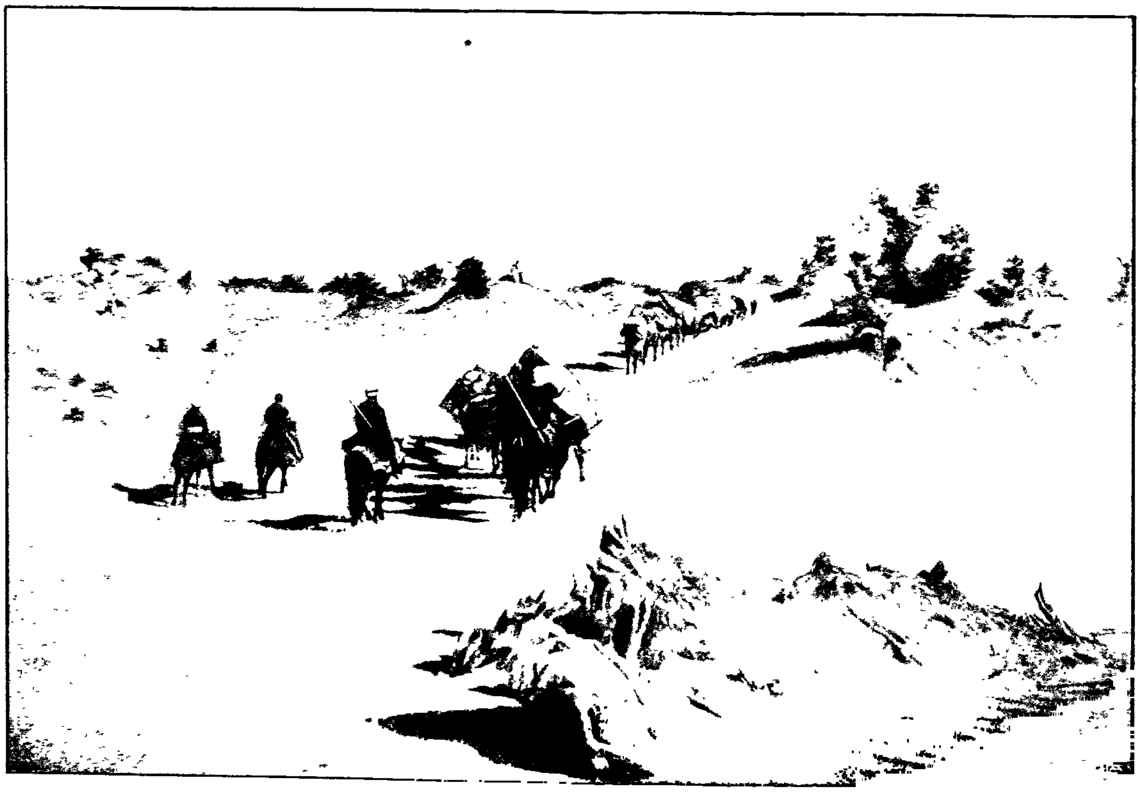


Fig. 9. TAMARISK-MOUNDS BETWEEN THE KONTSCHE-DARJA AND BASCH-TOGHRAK.

travels towards the south-west. The Kontsche-darja follows step by step hard after it. The rivers shift their courses towards the right, that is to say precisely in the directions in which one would expect the greatest hindrances to lie. The Tarim has to wash away the gigantic dunes of the sandy desert; the Kontsche-darja to chisel away the elevated inter-riverine tract, overgrown, as it is, with vegetation. The movement of the river is illustrated in the accompanying vertical section (fig. 8). The question naturally arises, what is the cause of this movement towards the right. The reason the river shifts its course is that it is gradually filling up with sedimentary matter, and is thus being elevated too high relatively to the adjacent country. But if that were all, the river would deviate now to the one side, now to the other; instead of doing that however, it always moves towards the right. For this, then, there must exist some other cause. No doubt the general slope of the country as a whole is towards the south-west, from the Kuruk-tagh towards the central parts of the desert. Secular changes of level, the effect (according to von Baer's law) of the rotation of the earth, the results of wind erosion, which is especially active in certain parts of the desert, and perhaps other causes as well, may all co-operate to produce the actual result we see before our eyes. In this particular part that we are now considering the migration seems to be taking place pretty swiftly, for huts were still standing beside watercourse No. 1. With each step that the river takes towards the south-west, it leaves behind it a strip of forest, and this, owing to the sudden stoppage

Fig. 10. BASCH-TOGHRAK.

of the water-supply, has died out. The fact of there being no forest beside watercourse No. 3 may be explained either by its being so old that its forest has been destroyed, or — and this is the more likely explanation — the river flowed that way for such a short period that the forest had no opportunity to establish itself.

To the north of this third watercourse stretches a tract of barren schor, hard and bare, with patches of thin sand at intervals. The only vegetation that was to be discovered there consisted of a few dead toghraks, white and silvery, and the gnarled and brittle trunks of tamarisks, which in other places have entirely disappeared since they have been deprived of water. Then came a few sporadic *könruk* bushes (a species of tamarisk), some with, others without, the usual mounds. These were especially numerous and luxuriant in the dry bed of a *sil*.* It is very seldom however that the rain-water comes down this way; when it does, it forms a transient lake south-east of the spot where we crossed it, but it never gets down to the river.

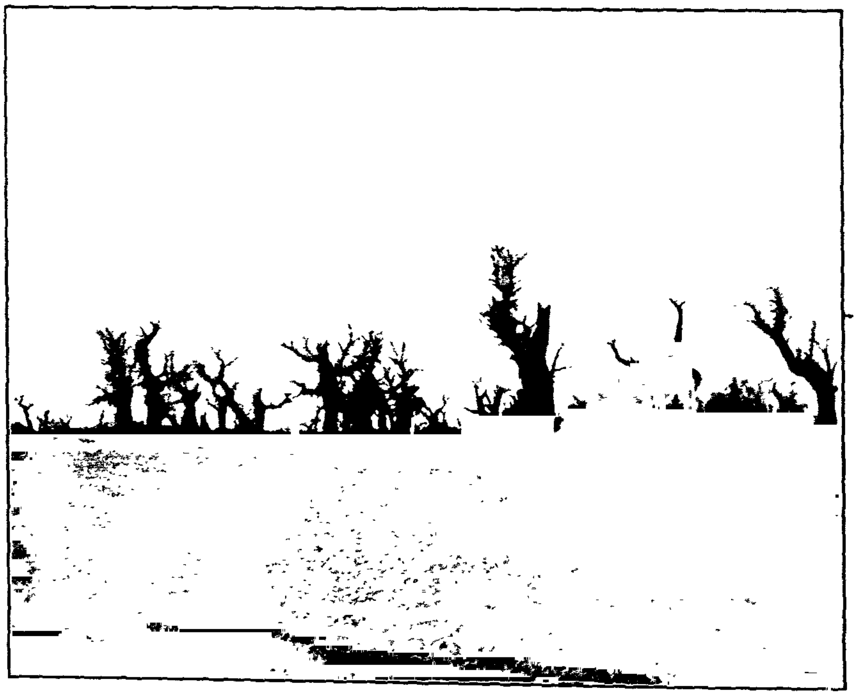


Fig. 11. BASCH-TOGHRAK.

After a region of alternating tamarisk steppe and schor, we crossed a pretty broad depression, in which was some living, though scanty, kamisch. According to my guides, this again was an old bed of the Kontsche-darja; but it was so ill-defined that I was unable to form any opinion with regard to it. Generally the natives consider that the Kum-darja has its origin at Saj-tscheke. In fact on the left side of the Kontsche there are so many old river-beds, that it is not easy to determine which is immediately connected with the Kum-darja, unless one follows up the old river-bed from Jing-pen until one comes to its actual junction with the Kontsche. The depression containing kamisch, which I have just mentioned, might equally well be one that goes down so close to the ground-water that the kamisch is able to maintain itself there fresh and vigorous.

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* *Sil* = "overflow", i. e. temporary, occasioned by a violent shower in the mountains.

Immediately north of the belt of kamisch is a slightly raised terrace, crowned with a small, isolated poplar forest, called Basch-toghrak or Kaltaning-basch-toghraghi; its big massive trees measured as much as 3.77 m. in circumference, though they are gnarled and stumpy, with few branches and twigs, so that the crown is disproportionally small as compared with the stem. Dead trees are also plentiful. In fact, the clump of forest appears to be dying out. Here we crossed over a little track, the same that I followed from Korla to Jing-pen in 1896. To the east-south-east, at Kalta proper, where I at that time stopped beside a pool, there is yet another patch of forest. Kalta and Basch-toghrak are said to be almost equidistant from the river. At Kalta, again, there exist traces of an old river-bed. Three or four kilometers to the left stands the *tora* of Basch-toghrak. This, like the other roadside pyramids in this locality, was built beside the old bridle-path between Lop-nor and Korla, a road known to the Lopliks as Kömür-saldi. An old man, Aksakal of Jangi-köl, who gave me much valuable information, asserted that in former times this road ran eastwards along the southern foot of the Kuruk-tagh, and eventually joined the road that led to Dung-chan (Tung-chuan). In arriving at a conclusion such as this the native is guided solely by the presence of the pyramids, which bear of course palpable evidence of the some time existence of a road beside them.

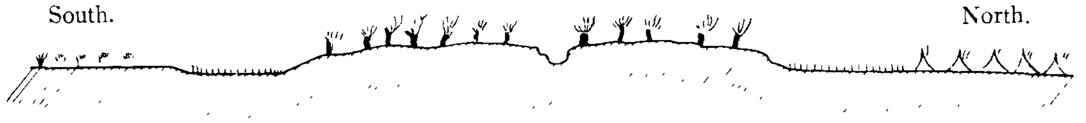

Fig. 12. VERTICAL SECTION AT BASCH-TOGHRAK.

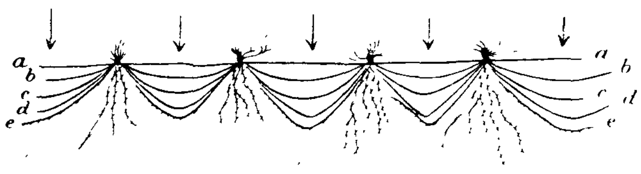

Fig. 13. FORMATION OF TAMARISK-MOUNDS.

On the north too the little terrace of Basch-toghrak is bordered by a relative depression, containing a sprinkling of kamisch. Thus, as the subjoined section (fig. 12) shows, the oasis forms an insular elevation, raised a few meters above the level surface around. This conformation affords an especially convincing proof of the effects which vegetation produces upon the surface levels, as I have assumed above for the entire stretch of country between the Tarim and the Kontsche-darja. The relatively barren soil around Basch-toghrak — or if it is not quite barren, the vegetation is at all events very sparse — has, under the incessant filing of the wind, given place to a relative depression; but Basch-toghrak itself has been preserved by the binding force of the roots of the toghraks. At the same time the drift-dust which has dropped upon the oasis has been retained there by the trees and their roots; whereas upon the circumjacent bare soil this æolian deposit has been unable to maintain its footing, but has always been swept on farther by the wind.

Our path continued to wind on through a belt of especially numerous tamarisk-mounds, unusually big and lofty, and crowned by living bushes. This conformation, again, bears witness to the influence of the wind. Let us suppose that these tamarisks originally took root on the perfectly level ground (*a—a* in fig. 13), then the points where the bushes are growing become protected against the erosive force of the wind, and it is only the intervening spaces (indicated by arrows) that are exposed to it. Consequently these intervening spaces are gradually hollowed out to the successive positions *b—b*, *c—c*, *d—d*, *e—e*, the elevation of the tamarisk-mounds growing at the same time relatively higher with each successive downward step of the surrounding soil. Hence, when one rides amongst a series of mounds of this description, 3 and 4 m. above the general level, one may safely take it for granted, that the summits of the mounds, where the tamarisks rest, were once *au niveau* with the general level of the country. In the sequel we shall come across yet other proofs of the correctness of this reasoning.*

The belt of tamarisks is succeeded by hard and perfectly barren *saj*, i. e. hard, sterile soil with a thin sprinkling of gravelly *débris* on the surface. This superficial covering gradually increased in quantity as we approached the mountains, while an occasional solitary tamarisk or *jantak* bush was the sole representative of the vegetation. The saj formation is traversed by the lower part of a dry torrent or bed of a *sil*, its course being indicated by a double line of erosion faces, barely a foot high, and frequently indistinguishable, inclosing between them a winding ribbon of fine sedimentary clay, almost white in colour. Here the steppe scrub is more abundant, although the water-supply must be of the very scantiest, being limited to the very rare occasions when the rain torrents of the Kuruk-tagh succeed in getting thus far down. Farther along too, on the sides of the watercourse, there is a sprinkling of steppe scrub, growing on small mounds. The rest of the way, to the foot of the mountains, we travelled up this watercourse, which issues from the glen of the Suget-bulak. The scenery is dreary and monotonous, and the soil barren. And so gentle is the ascent towards the Kuruk-tagh that it is imperceptible to the eye. The desolate saj stretched all around us as level as the sea; the only animals we saw all day were a couple of shy antelopes. During the march the contours of the mountains, which had been visible ever since we left the Kontsche-darja, came out more and more distinctly. When we reached the lower part of the saj we were able to make out certain of their details — the mouths of the glens, the hollows of the mountains, and their shadows. From the same spot we were able to perceive, although indistinctly, the belt of vegetation alongside the Kontsche, showing like a dark line on the southern horizon, where it framed in the grey, monotonous expanse of the saj. This is, as I have already indicated, seldom broken by any departure from the dead level, and even then the elevation is trifling.

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* *Vide* vol. I. pp. 322, 401 etc., and cf. figs. 272, 284, 357.

Next we travelled almost due N. 35° E., still keeping to the watercourse, which now wound but little. Here, where there is a more copious supply of water from the mountains, the steppe scrub flourishes rather better. By this the ascent had become perceptible to the eye. In this eroded trench we came across some pieces of driftwood, at first rather sparingly, but afterwards more numerously; it consisted of *kara-jaghatsch*, *suget* or *tal* (willow), and tamarisks, and evidently had been washed by the torrents out of the glen of the Suget-bulak, where these three varieties of tree grow. On both sides of us we had the vertical *jars*, or »erosion terraces«, which shut in the trench of the Suget-bulak, at first some distance apart, though afterwards they approached closer together. They are built up chiefly of fine material in different layers of varying thickness. They measure 2 to 3 m. in vertical face, and embrace no big blocks. In two or three places on the left or eastern side we found a few small snow-drifts still surviving, showing that snow falls in winter even in this locality. In the middle of the watercourse there occur a few table-topped, or cubical fragments of erosion terraces, which have been modelled by the torrent. The trumpet-shaped mouth of the glen grew more and more distinct, and eventually the lower spurs of the mountains began to rise on both sides of us. At the point where we halted in the middle of the watercourse, the eastern *jar* was still distinct; but on the opposite side its place was taken by hard rock, a species of stone friable and weathered beyond recognition, lying 65° N.W. A rivulet of gloriously limpid water, issuing from the spring of Suget-bulak, trickled along its foot, and beside it stands the solitary willow (*suget*) from which the spring derives its name. The spring itself is said to lie a short day's journey up the glen from its mouth. The water that issues from it is stated to form a not inconsiderable brook, with a lively musical flow, though a good deal of the water is lost amongst the gravel on its way down. My guide, Abdu Rehim, asserted that once and again, after a violent rain, the little glen will be filled from side to side with a tumultuous torrent, though none of it ever gets down as far as the Kontsche-darja. The freshets that arise from the melting of the snow in spring are on the other hand always trivial.

From the exit of the glen it is reported to be 10 potaj up to Altun-keni (kan), or the gold-mine, where some half a hundred Tungans, Chinese, and Mongols, but no Mussulmans, collect gold-dust in the bed of the stream.

By making use of the glen of Suget-bulak one can, in three or four days, reach the Baghrasch-köl, although there is no track in the proper sense of the term, and on the way one has to surmount a pretty difficult pass, which horses and asses can just manage to get over at a pinch. In the upper part of the valley *kara-jaghatsch* occurs, and on and about the pass *artschin* or *artscha* (i. e. juniper); both these species appear to be conifers. Snow is said to lie on the pass for five months, disappearing finally towards the end of April. The snow which falls in October and the beginning of November does not remain on the ground, but melts away. According to Abdu Rehim, it was two days' journey from Suget-bulak to the nearest Mongols, who, with their flocks of sheep, lead a nomad existence in these mountains; the locality they most frequent is one richly supplied with pasture and surrounded on all sides by mountains. They live in small communities of a few *jurts* (tents) each.

The following were given to me as the names of the glens and springs, in character resembling Suget-bulak, as one proceeds from east to west: — Tschortschor, Kötäklik, Tugha-baschi (over against Saj-tscheke), Kulan-baschi, and Tschige-bulak, which is stated to be one day's journey south-east of Schinalgha (Schinnegha). The employment of the names *tugha* and *kulan* betray that this district used formerly to be visited by the wild camel and the wild ass; but at the present time the latter are never found there, and the former do not come so far west.

At our camp two glens met together to form one; they appeared to embrace between them a large spur or transverse offshot of the main range of the Kuruktagh. Of these two glens it is the eastern one which is called Suget-bulak, and which possesses the spring and brook. The other or western glen is likewise hemmed in on its western side by a very large spur. In the eastern glen not far up from the mouth both grass and kamisch grow plentifully, and as there was also an abundance of water and fuel, we had an ideal encampment, especially as compared with the sultry desert.

# CHAPTER II.

## THE KURUK-TAGH AND JING-PEN.

A crisp breeze blew down the valley all night, and for the first time that year the thermometer did not descend below zero, the minimum being + 1°.3 C. On the morning of 8th March the brook carried 88.5 cub.decimeter per second. After advancing a little way up the glen, we climbed to the top of the gravel-and-shingle terrace on the left. Thereupon we directed our steps towards the east-south-east, keeping near the foot of the mountains, and crossing over innumerable tiny rivulets, all of which were dry, and some of which contained drift-wood, an indication that some of the smaller glens bear vegetation. The hard, gently sloping saj, strewn with débris and easy to travel over, was dotted with thin scrub. Every now and again we saw *arkaris* (or wild sheep), antelopes, hares, and *teschikans*,

Fig. 14. MOUNTAIN SCENERY ON THE ROAD BETWEEN SUGET-BULAK AND KURBANTSCHIK.

this last a species of small rodent. On our left we had an incessantly changing mountain panorama, countless pinnacled summits coming into view one after the other, while countless other jagged tops became successively lost to sight behind us. The perspective was confusing; it was difficult to grasp the real architecture of the system, seen thus from the saj, and without having an opportunity to cross it transversely. As you look towards the east, the range appears to send out an endless series of spurs arranged *en échelon;* but when you look towards the north you see nothing but, apparently, a single continuous, uninterrupted chain. Passing the lower end of a glen, and glancing up it, you see, a long way off at its upper end, a line which you take to be the main crest of the Kuruk-tagh. The peaks nearest to our route, being those by which I plotted my map, appeared to belong to a subsidiary range,

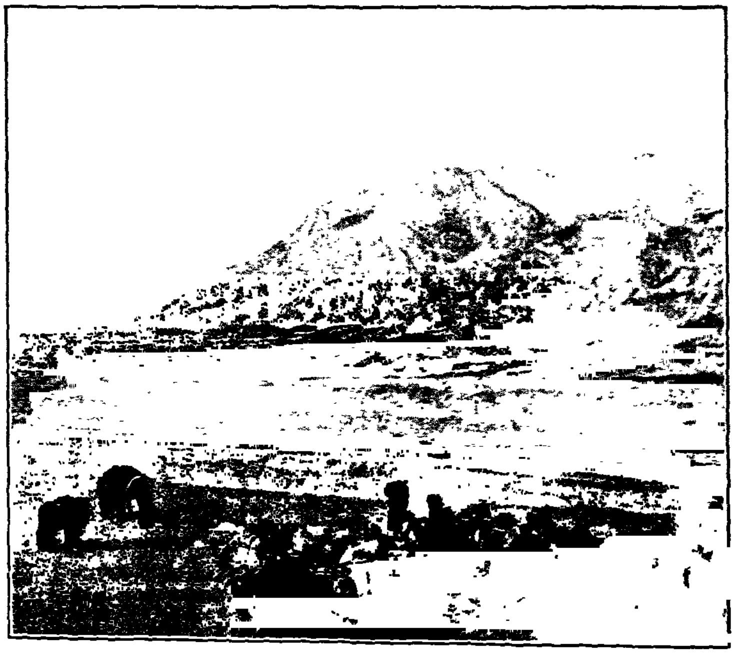


Fig. 15. MOUNTAIN SCENERY ON THE ROAD BETWEEN SUGET-BULAK AND KURBANTSCHIK.

lying parallel to the main range and broken by all the transverse glens; but this was probably only an illusion. As an actual fact what we see from the saj consists only of the subdivisions of the transverse spurs, and of ramifications of the main chain which present themselves in shortened perspective. The transverse glens or valleys run southwards between these ramifications, starting close up against the main crest, and terminating in the saj after they emerge from the mountains. The colouring of the mountains was subdued and faint, the chief tones being brown, violet, red, grey, and yellow, and these were still further softened by the light clouds that drifted abovehead. On the right, that is towards the south, the detritus slope of the saj stretches evenly, in its barren desolation, down to the level plain in which the Kontsche-darja has from time to time shifted its bed and its position. The belt of forest beside this stream was no longer visible; in the far distance the horizon brightened up in some places, while in others it was veiled in a thick haze. But on the nearer side of this we could distinguish a succession of rather darker strips, probably the different varieties of ground formation and the different belts of vegetation which we crossed on our way between Dilpar and Suget-bulak. On the east we had all day a dominating section of the range, which still retained a good deal of snow in sheltered crevices on its eastern flank.

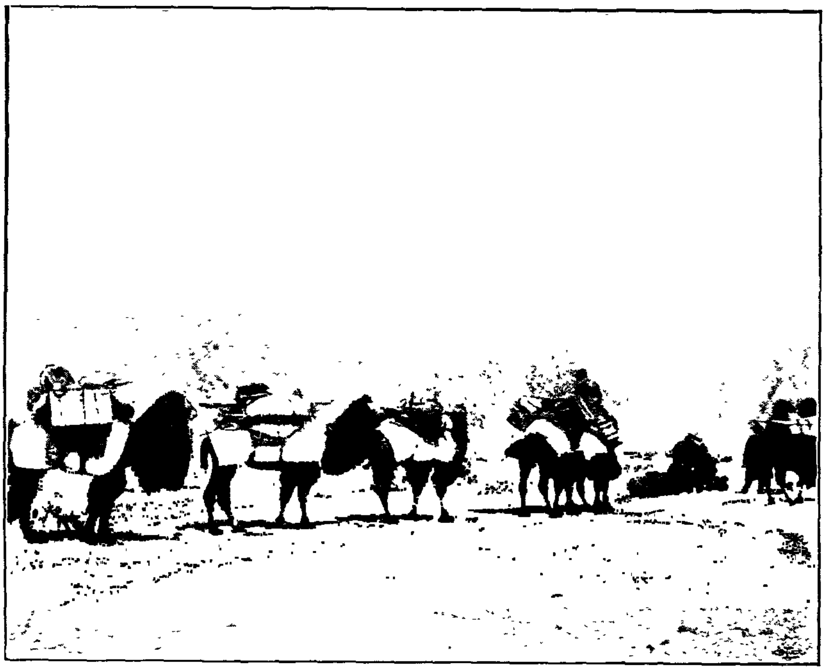


Fig. 16. MOUNTAIN SCENERY ON THE ROAD BETWEEN SUGET-BULAK AND KURBANTSCHIK.

The transverse glen of Örtäng-bulak points towards the south-west, and the dry torrent which descends it is enclosed between rounded erosion terraces and contains some drift-wood. As the name *bulak* indicates, there is a spring in this glen also, but the rivulet to which it gives rise does not get down to the mouth of the glen. The next transverse glen, Kuruk-akin, possesses a very broad and distinctly trenched watercourse; but here again there is no permanent stream. Nevertheless it appears to drain a very extensive area amongst the mountains; and this would indeed seem to be borne out by the degree to which its erosive effects have been developed.

Next we turned to the east-north-east, passing a good many shallow rivulets, separated from one another by hills, until finally we found ourselves on the edge of the sharp-cut depression of Kurbantschik, a deeply sculptured trench or cauldron, some 30 or 40 m. deep. It is inclosed by gigantic beds of gravel-and-shingle, fairly rounded and weathered, and pierced in places by the naked rock. We reached the bottom of the cauldron by a steep ravine. A vivacious little brook rippled amongst the soft cakes of ice with which its stony channel was littered. Its volume measured 82.8 cub.decimeters in the second, and yet owing to its greater breadth it appeared to be bigger than the brook of Suget-bulak. *Kara-jaghatsch* and tamarisks were growing on its left side. A little to the south there is a small deep basin of beautiful emerald green water, traversed by a rivulet from the main brook. This little basin lies at the termination of a side-ravine, and has evidently been hollowed out by the waterfall which no doubt is created there after rain. Near our camp I noticed a dark green variety of rock lying 67° N. 5° E., though the position was not very distinct. Amongst the detritus of the gravel-and-shingle there were however a species of graphitoid slate, crystalline schists, pegmatite, etc.

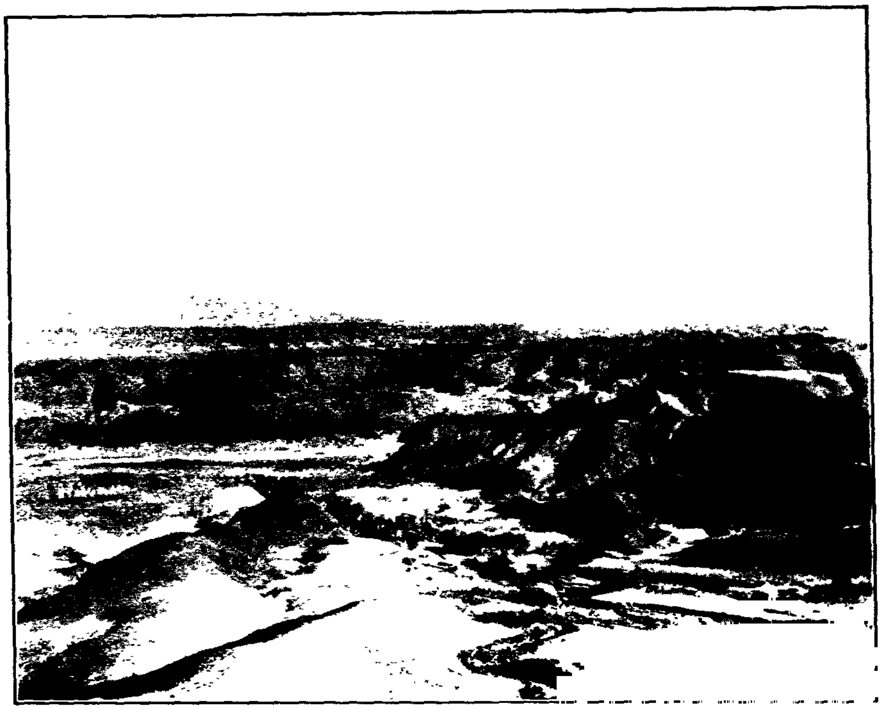


Fig. 17. RAVINES IN THE FOOTHILLS NEAR KURBANTSCHIK.

One of my servants, Chodai Kulu, a hunter from Jangi-köl, had once been up the glen of Kurbantschik; he described it as being tolerably broad, with an abundance of toghrak, kara-jaghatsch, and tamarisks in the expansions. It was two or three kilometers farther to the spring, or *bulak-baschi*, and beyond it comes what he described as *asma* or *igis-jer*, that is a region situated at a high altitude. According to Abdu Rehim, my guide, it is $2^{1}/_{2}$ days' journey from the mouth of the glen to the crest of the main chain, this glen and the glen of Suget-bulak both terminating at the same pass, called Töbve by the Mongols, but quite simply Davan (pass) by the Mussulmans. It is stated to lie three days west of Singer. From Davan to the Baghrasch-köl is a journey of $1^{1}/_{2}$ days, so that the main chain lies nearer to this lake than it does to the mouth of the glen on the south. The open *jajlaks* or pasture-grounds that the Mongols range over are said to lie on the south side of the main crest; their name is Schare-ghadser, or the Yellow Tract. The country between the main crest and the Baghrasch-köl is reported to consist of barren and desolate saj. The Kurbantschik is named after an old *pavan*, or »hunter», of the name of Kurban. From that spot to Masar on the Kontsche-darja it is a stiffish day's march by a desert track.

On 9th March we rode a pretty considerable distance south down the glen of Kurbantschik. Its erosion terraces are very distinctly marked, and on the top are diversified by hills and small outcrops of rock. Close under the terrace on the left side of the glen there are a dozen magnificent kara-jaghatsch trees, which with their pendent plume-like branches must afford excellent shade in the summer, converting the space underneath into a veritable tent. The brook from the spring came to an end a short distance below our camp, after having spread itself out and formed a large sheet of soft ice. Quitting this glen by a side-ravine, we directed our steps to the south-east across slightly undulating saj, thinly sprinkled with scrub and furrowed by shallow gullies. But one such trench that we crossed was deeply scored in the ground, an indication that it issues from a transverse glen of the Kuruk-tagh. South-east of this last lies a tangle of hills and ravines, and beyond them we entered a sort of »corridor» glen, indistinguishable in places from a fissure-like hollow defile, which is joined on both sides by a number of similar contracted ravines. This labyrinth of eroded trenches or deep gullies is carved at first through soft material and shut in by rounded hills; but eventually it terminates in a valley encircled by hard rock, the bedding of which dips 63° N. In many places this valley is fenced in by high and perfectly perpendicular walls of rock. Its floor however is level and dry, has a very gentle slope towards the south-east, and is littered with coarse sand or gravel. After a while it inclines towards the south, being at the same time joined by a side-glen. In the expansion thus formed not only are there magnificent toghraks and thick luxuriant reeds, but a spring also gushes out, and this had given rise to spacious sheets of ice in the bottom of the valley. This sheltered and charming little oasis is called, as one might almost guess, Toghrak-

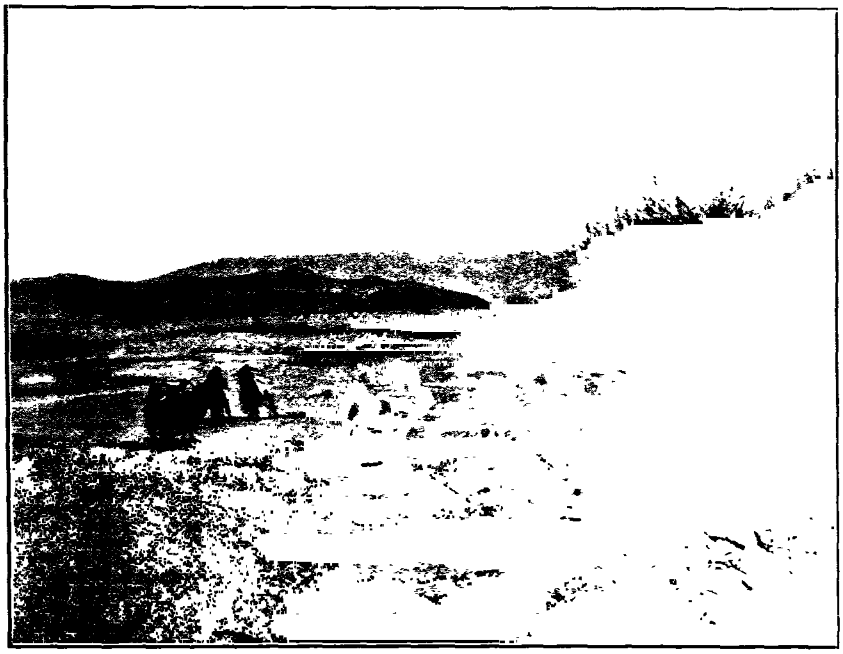


Fig. 18. OUR CAMP AT KURBANTSCHIK.

bulak. Remains of a fire showed that it had recently been visited, probably by hunters from Korla. Just below Toghrak-bulak the valley debouches again upon the open saj; so that we had in reality crossed over a spur of the Kuruk-tagh that juts out a long way towards the south.

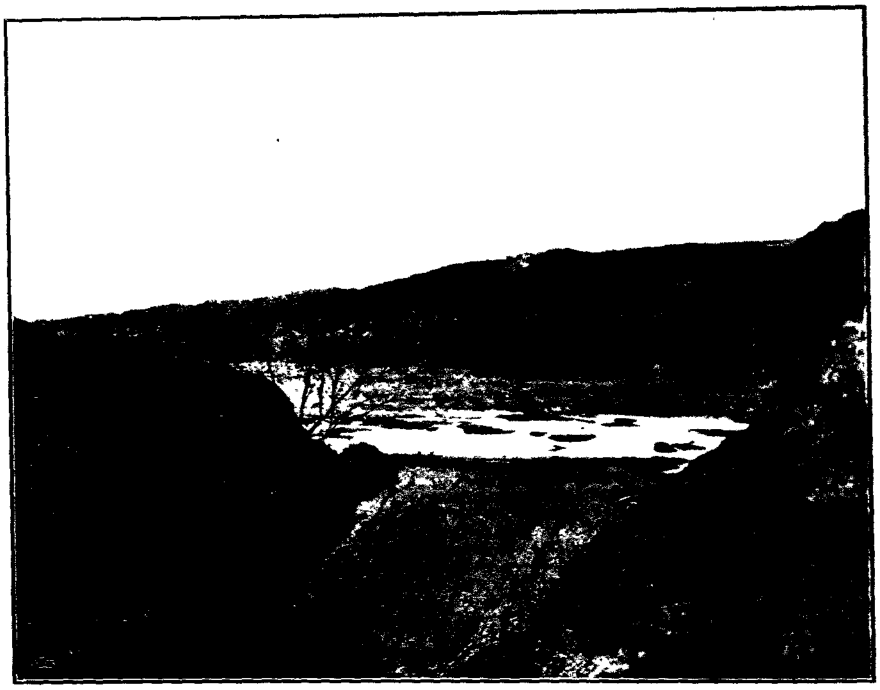
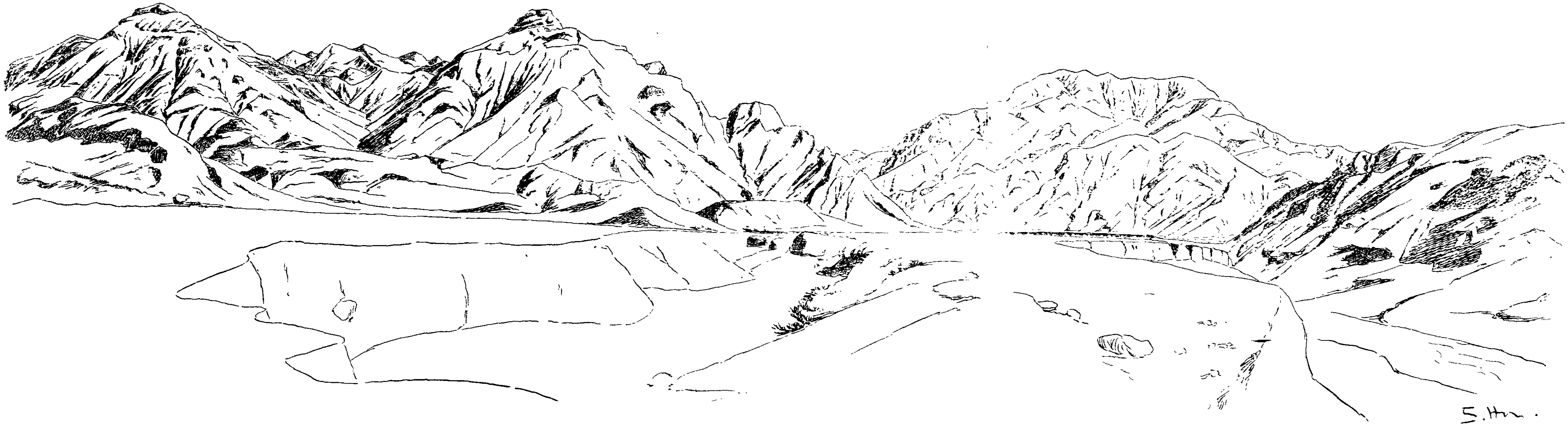


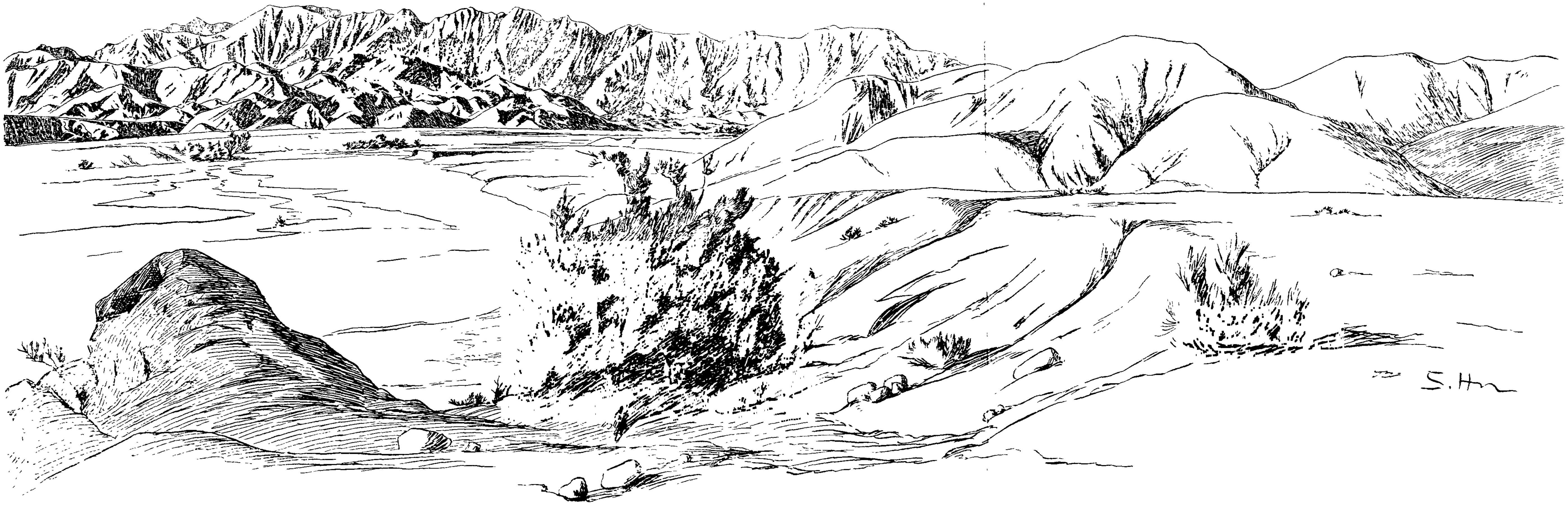
Fig. 19. KURBANTSCHIK; THE DEEP BASIN IN THE FOREGROUND.

We were now once more travelling towards the east, having the mountains on our left and the gently sloping saj, with its sparse vegetation, on our right. The latter still remained quite level, although furrowed by innumerable small gullies, about a foot deep, but filled with stones and gravel. There were no deeper trenches indicative of the existence of side-glens. And these characteristics the scenery retained for the rest of the way. Just before reaching the spring-brook of Budschentu-bulak we observed a glittering white spur of the mountains jutting out west of a deep, but dry, ravine, with an erosion terrace 3 m. high on the right: this ravine only carries water however after rain. The brook of the Budschentu-bulak issues from a side-glen of the Kuruk-tagh, and proceeds farther south than its fellows, though only a few kilometers, and then it too disappears amongst the detritus of the gravelly scree. Here its bed is very broad, though not very distinctly marked, is choked with stones and gravel, and contains also some drift-wood; at the time of our visit it also was caked with ice. The brook itself was split up into a number of rivulets, rippling along underneath the ice. This was the largest stream we crossed whilst travelling along the foot of the Kuruk-tagh.

At Budschentu-bulak we emerged from the Kuruk-tagh, in quest of the dry river-bed which was the principal object of the expedition. The orography of the Kuruk-tagh is far from being understood, especially towards the west. Kosloff



View looking N 30° E from camp at Budschentu-bulak



View of Kurbantschik, looking N 10° W

Drawn by Dr. Sven Hedin

Generalstabens Litog. [illegible] Stockholm

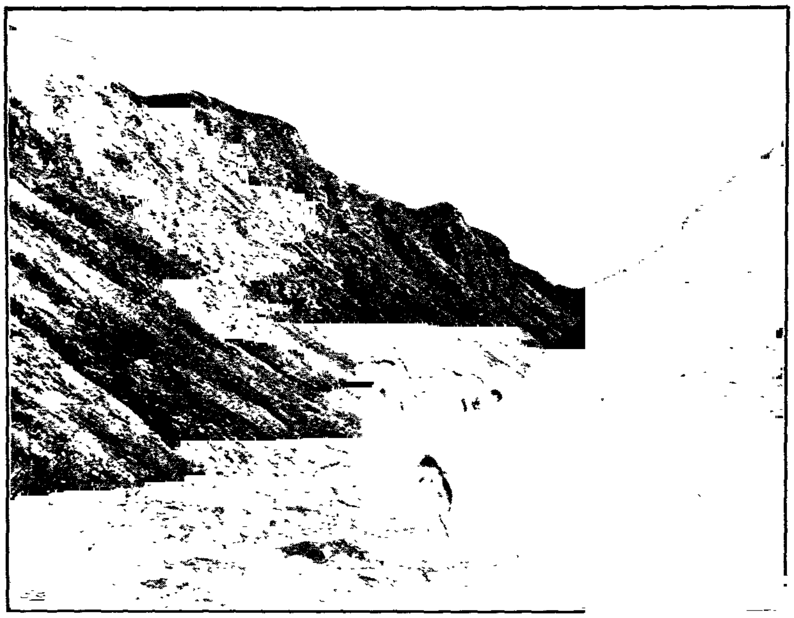


Fig. 20. SCENERY IN THE VALLEY S.E. OF KURBANTSCHIK.

crossed it by the Turfan route *via* Singer, Grum-Grschimajlo crossed it between Luktschin and Olun-temen-tu, and I crossed it farther to the east. This has made indeed a great part of the system known; but the western parts depicted on our maps are certainly incorrect, if not imaginary. Grum-Grschimajlo* shows on his

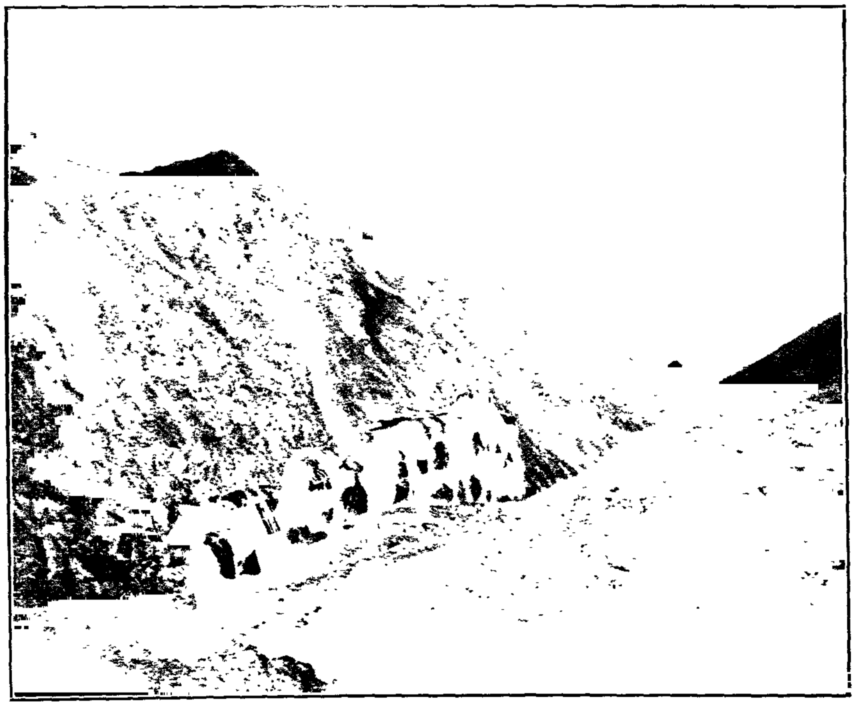


Fig. 21. SCENERY IN THE VALLEY S.E. OF KURBANTSCHIK.

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* See his *Opisanije puteschestvija v Sapadnij Kitaj*, tome I.

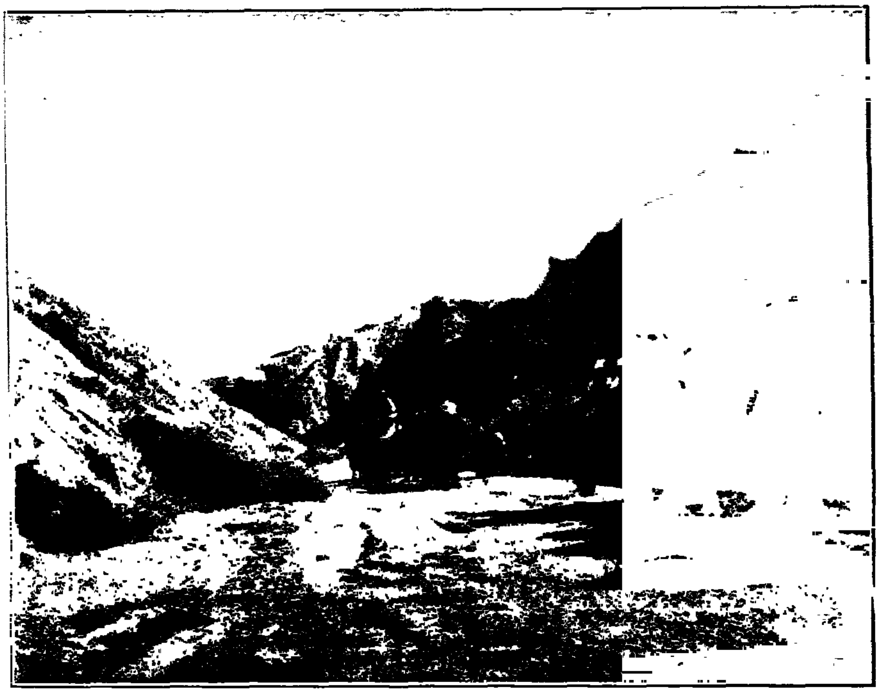

Fig. 22. SCENERY IN THE VALLEY S.E. OF KURBANTSCHIK.

map of this region two nearly parallel chains, calling the northern one Chara-teken-ula and Singer, and the southern one Kuruk-tagh. Kosloff, who mapped the Baghrasch-köl during Pjevtsoff's expedition, also depicts two chains south of the lake, namely the Chara-teken-ula and its eastern continuation, the Kisil-sangir-tagh, in

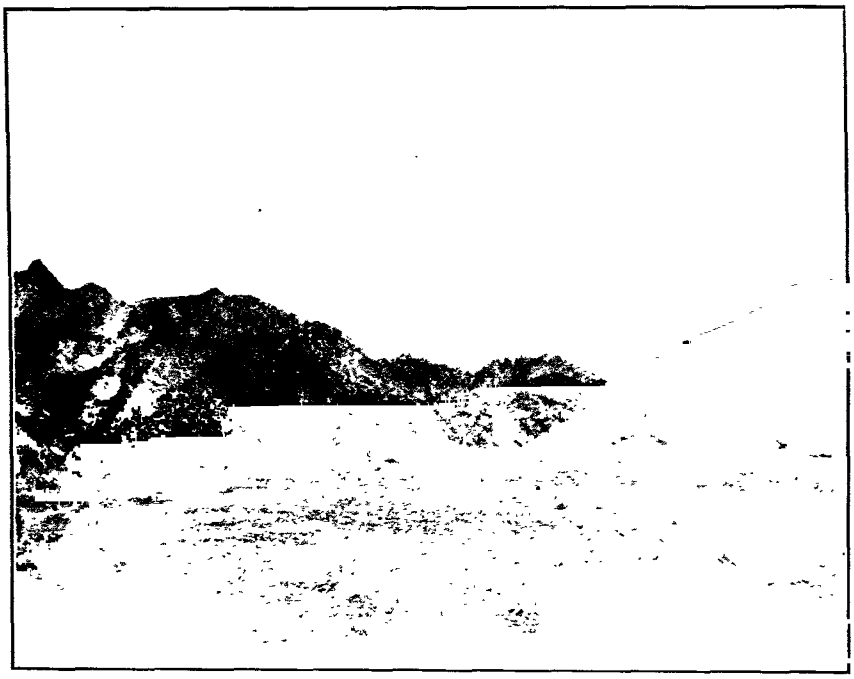

Fig. 23. SCENERY IN THE VALLEY S.E. OF KURBANTSCHIK.

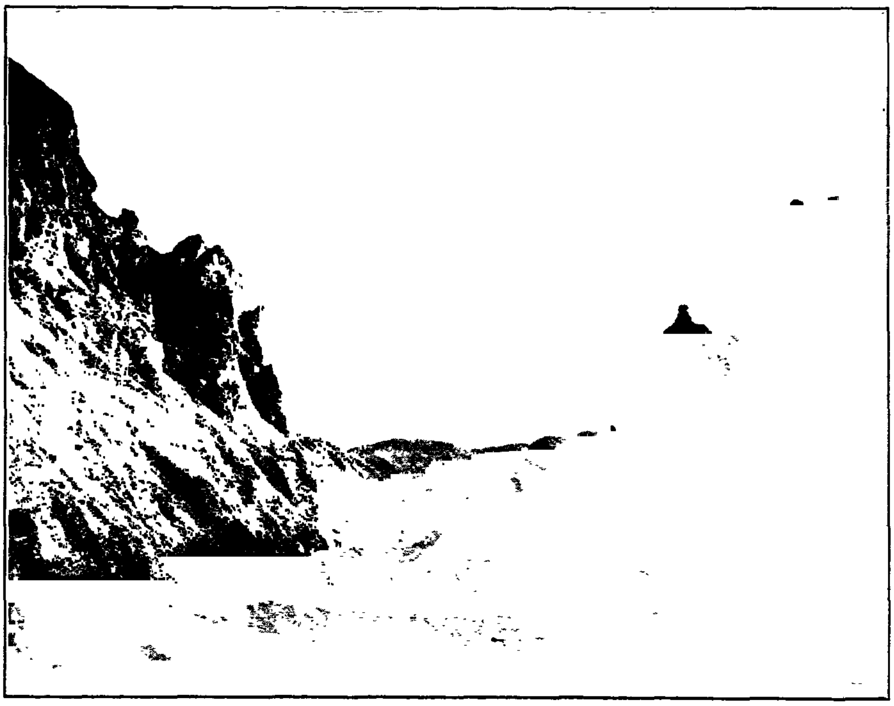

Fig. 24. BROAD PARTS OF THE VALLEY S.E. OF KURBANTSCHIK.

addition to the Kuruk-tagh. Dr. Hassenstein also inserted them both on my map in *Petermanns Mitteilungen*. But in the light of the information given to me by men well versed in the local topography, I am disposed to think that as an actual fact there exists here but one mountain-chain, and that it forms a dividing wall as

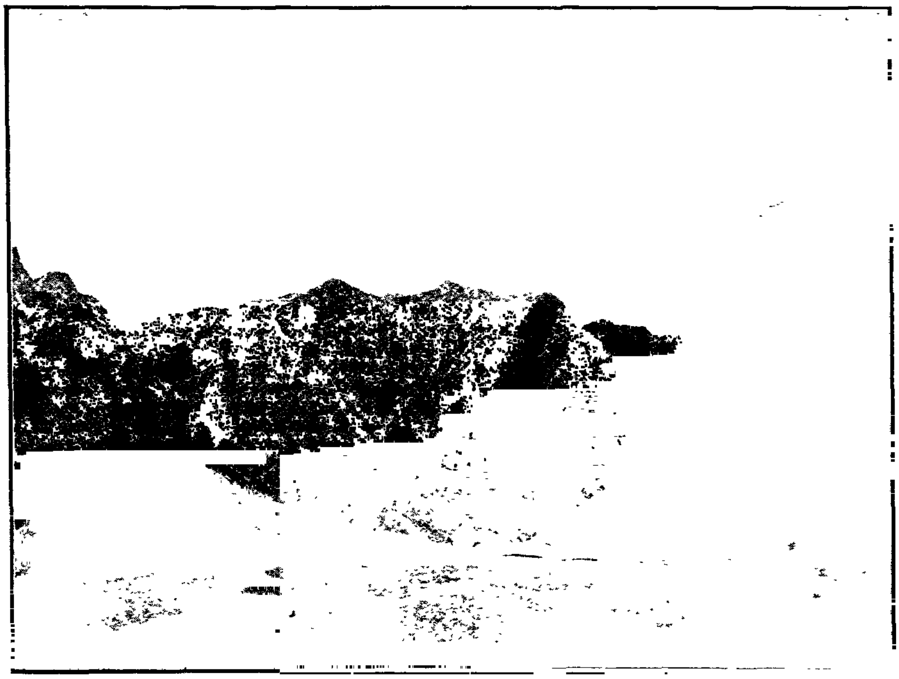

Fig. 25. BROAD PARTS OF THE VALLEY S.E. OF KURBANTSCHIK.

well as the watershed between the Baghrasch-köl and the Kontsche-darja. All the transverse glens, with spring water coursing down them, that open out from the Kuruk-tagh to the south appear to lead up to a single pass in a single chain, and over on the other side of it the surface slopes down to the desert-like lowlands which stretch along the southern shore of the Baghrasch-köl. It is quite possible that on the one side or the other of this principal chain there does lie a smaller parallel chain; but if so, it is of secondary importance and is pierced by the transverse glens of the main chain. Thus, even though we may with some show of justice maintain that the existing maps of this mountainous region are the outcome of imagination, it is no less incumbent upon us to abstain from making alterations in them until by fresh exploration we have acquired fuller information with regard to the orography of the region. But as both the Russian travellers whom I have named, as well as I myself, have ascertained that the eastern part of the Kuruk-tagh consists of several parallel chains, though it is true of very inconsiderable dimensions, there is reason to suppose, that the range splits into several divisions, which radiate fan-like towards the east, in the same way as the Kwen-lun system does, though in its case on an immeasurably vaster scale.

Fig. 26. TOGHRAK-BULAK OR ASTIN-BULAK.

Before I leave the Kuruk-tagh I will point, *en passant*, to the relation which this mountain-range bears to the shifting of the bed of the Kum-darja, or, as I shall prefer to call it in these pages, the Kuruk-darja. What is it we have to consider? We have a mountain-range running from west to east and a river flowing parallel to it, close along its southern foot. Then, disregarding other physical influences, such as secular changes of level and the effects of the earth's rotation, we may ask, what effect does this range exercise upon the situation of the river, — does it repel it or does it attract it? My answer to this is, that it must of necessity repel the river, — that is on the assumption that the latter is situated sufficiently near to the base of the mountains. The line *a a, a,,* in fig. 27 and 28 indicates the vertical section of a mountain-slope, with a plain at its foot along which a river flows parallel to the base of the mountain. Matter is removed from the face of the slope by weathering in the same proportion as the detritus-scree at its foot, composed of the accumulated products of the disintegrating process, goes on increasing After a time the outline of the section assumes the shape shown by *b b, b,,*. As this process is accompanied by an extension outwards of the base of the detritus-scree, which at the same time grows flatter, the bank of the stream lying next the foot of the mountains is necessarily encroached upon. The mountains thus exercise a certain pressure upon the river, and compel it to shift its bed farther away from their base. In the sketch the vertical elevation is of course to a large extent exaggerated. But in reality, under the circumstances supposed, a transportation of material must take place, and what does take place is exactly what has happened at the southern foot of the Kuruk-tagh. The process is an extremely slow one, because of the rarity of the rainfall; but in this particular region, where the prevailing wind blows from the north-east, the rainfall has an active ally in the wind. During the course of centuries and tens of centuries the products of disintegration, which, after being loosened from the mountain sides by the frost and the action of the atmosphere, are deposited through the agency of the rains, that fall periodically with greater or less violence, cooperate gradually to raise the height of the detritus scree;

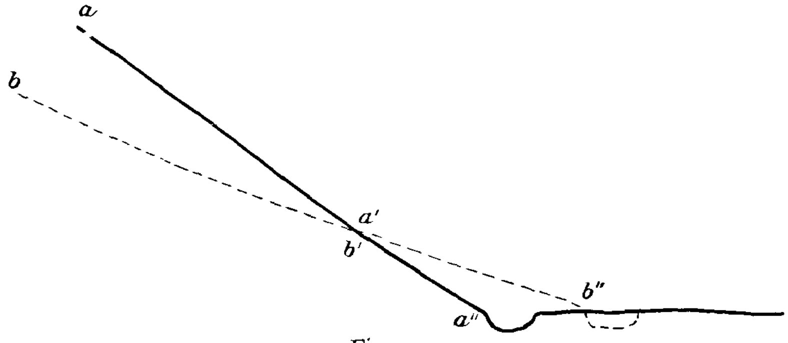

Fig. 27.

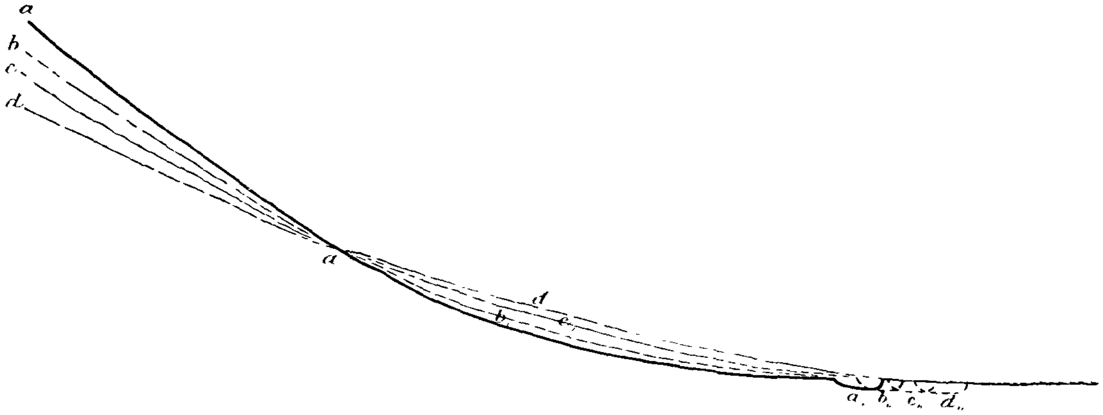

Fig. 28.

and this is likewise thrust farther south by the power of the water. These materials spread out at the foot of the mountain in a countless number of dry deltas, arranged fan-like, which merge into one another until they form a single detritus slope or base; while the finer material is carried farther in the same direction by the wind. The result of all these operations is to force the river-bed towards the south. In proportion as the contours are raised at the foot of the mountain-chain, in that same proportion the desert tracts south of the river-course are lowered through the erosive power of the wind, until eventually the difference of elevation is so great that the river is unable to maintain its position. And as a matter of fact we do know that the Kuruk-darja at the foot of the Kuruk-tagh actually has deserted its ancient bed, and has shifted its course to the south and south-west. I do not mean to assert that the circumstance of the Kuruk-tagh's crumbling to pieces, and its tendency to form at some time in the future a chain of detritus with a gentle descent towards the Desert of Lop, are the sole causes of the river's migration; I merely throw out the suggestion, that these circumstances have undoubtedly to a certain degree contributed to produce the hydrographical changes which have actually taken place in the face of the country. The real cause of the river's migration is its own activity, in that it goes on accumulating mud unceasingly, thus raising the level of its own bed, though in this work it is assisted by the vegetation. And even though the elevation of the detritus-scree had no effect upon these metamorphoses, it would at any rate prove an insurmountable hindrance to the river, once it had raised its bed sufficiently high, and prevented it from shifting its course towards the north. In this way therefore the growth of the detritus-slope acts as one of the causes of the river's constant movement towards the south, that is during the period of its history of which we have any knowledge. Yet other circumstances, as well as mechanical changes of level, might under other conditions contribute to force the actual Tarim back towards the north-east, as we shall subsequently see.

On 10th March we left Budschentu-bulak and steered our course towards the south-south-east; though once across the brook our direction was south and south-south-west, across desolate saj steppe, with scanty vegetation and an imperceptible slope towards the south. The amount of detritus gradually decreased. In the far distance to the south-south-west we could now make out, against the background of the desert-haze, the ruins of the *kona-schahr*, or »old town» of Jing-pen, of which Kosloff has given the following brief account. — »Five versts north-west of our bivouac were the ruins of the old town of Empen (i. e. Jing-pen). The walls of a fort and of several *fansas* still remain. The natives, in their eager search for buried treasure, have recently carried on excavations there, though without success. What epoch this ancient town belonged to, as well as who were its inhabitants, is not known to the natives».*

Just before we reached these ruins we again came across, on our right hand, the eroded trench of Budschentu-bulak, of course perfectly dry and almost without any gravel, yet far more distinctly marked than it was higher up, possibly owing to the fact that the material which it has here cut its way through is especially soft, namely fine-grained yellow clay. In this we have a proof of the fact that the torrential rains of the mountains do sometimes get thus far down; indeed the distance is only 19 km. A good bit above the ruins we passed an insignificant hollow, which my guides suggested had once been an artificial arik, for carrying water from the Budschentu-bulak to the old town of Jing-pen.

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* *Trudij Ekspeditsij Imp. Russ. Geo. Ob. po Tsentralnoj Asij, 1893—94*, p. 74.

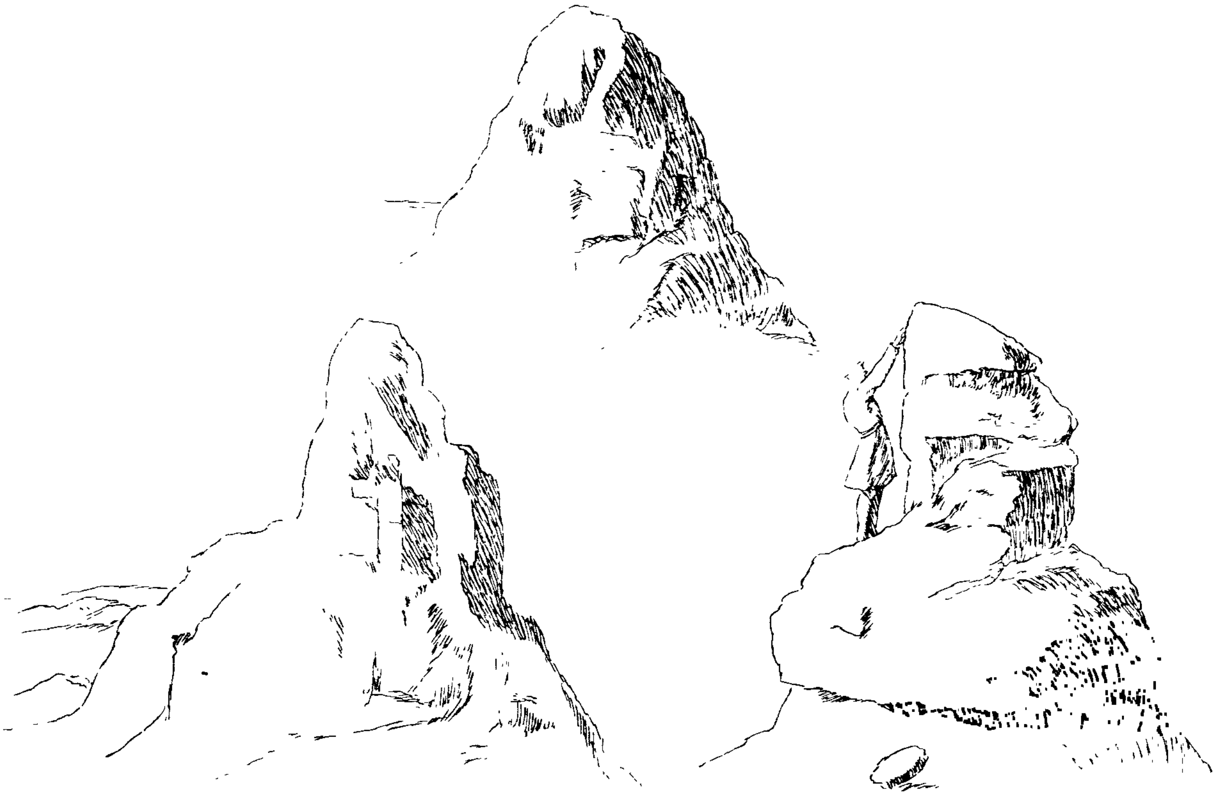

Fig. 29. THE TORAS AT JING-PEN.

The surviving ruins, which are not very remarkable, stretched in the direction in which we were travelling, so that by riding south-south-west I was able to see them all. The first ruin was a *tora*, or »clay tower», 14.50 m. in circumference at the base and 4.5 m. high, and in shape resembling a smaller cylinder superimposed upon a larger one. The second tora was like a bee-hive in shape, and likewise 4.5 m. in height. Both towers, like all the other ruins here, were built of sun-dried clay, after first being shaped, when moist, in rectangular frames either as cubical or as flat bricks, after the pattern and method still employed in East Turkestan. The perishable material was seriously decayed, and worn away by the wind and the drift-sand. Next came a *ghuristan*, or »burial-place», standing on the right bank of the dry bed; it contained some 30 graves, all arranged in the Mussulman fashion, with the feet pointing south and the head towards the north, while the face was turned towards *keble* (Mecca). Each grave was covered with a gravestone of the

Fig. 30 *a*. RUINS AT JING-PEN.

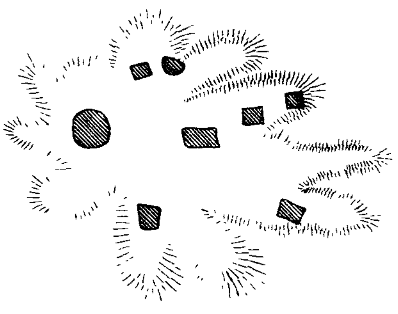

Fig. 30 *b.*

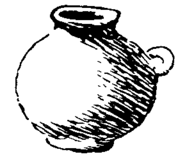

Fig. 31. CLAY POT FROM JING-PEN.

usual Mohamedan shape, likewise made of sun-dried clay, of the same kind as that common throughout the locality. The mountain torrents have within recent years attacked the right side of the gully to such an extent that it has washed away a portion of the ghuristan, so that the interior of some of the graves are now half exposed. A corpse, apparently that of a 15 year-old Mohammedan youth, which had recently fallen out, lay in the bed of the gully. The short hair, teeth, ears, and hands were fairly well preserved, the skin hung about the skeleton like parchment, a piece of cloth was bound round the head, the feet only were missing. The skull was of the Mussulman shape. My native guides had no hesitation whatever in recognising this ghuristan as a Mohammedan burial-place; indeed the position of the graves left no room whatever for doubt. I would not venture to determine its age; but it can hardly date back very far, at a guess say 150 to 200 years. Were it older than that the skeleton which I have just described would not have been so well preserved, but would undoubtedly have crumbled to pieces and the bones would have been bleached. Close beside the burial-place was a clay structure which may possibly have been a *mästschit*, a *chancka*, or a burial monument placed over the grave of some distinguished person. It consisted of three walls without a roof; the fourth wall, which stood on the verge of the gully, had evidently been washed away. The clay walls had been built up round a framework of posts and beams, imparting to it

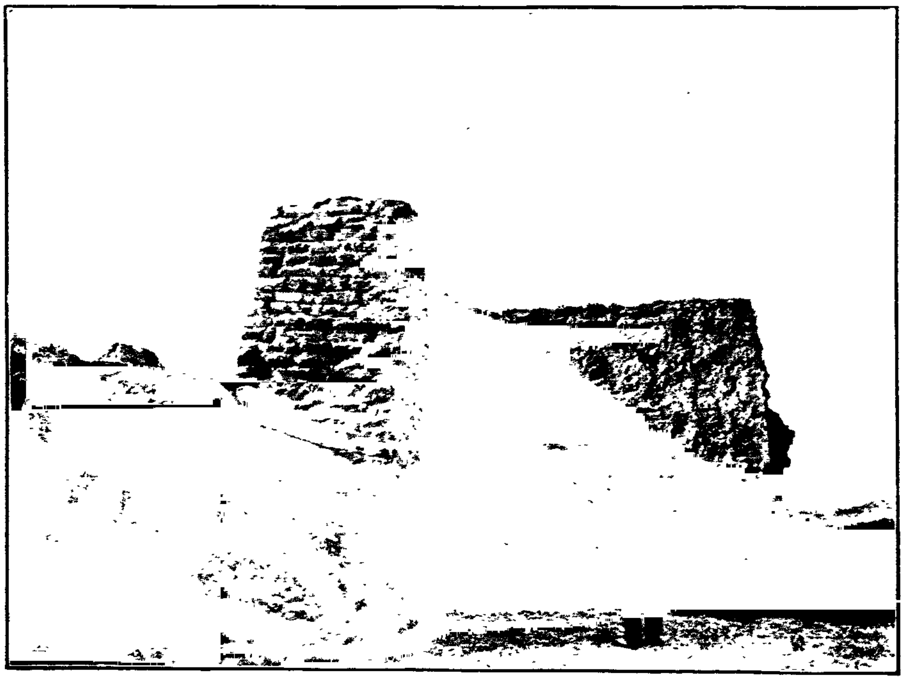

Fig. 32. RUIN AT JING-PEN.

greater power of resistance. The back wall was 6 m. long, the other two rather shorter. It was 4.13 m. above the bottom of the gully, and was level, with the native earth for its floor. In the vicinity were numerous shards of black and red clay jars. These were spherical in shape and of considerable size, and had a very small ear; they had manifestly been used for holding water.

Thence we rode on farther, keeping to the bottom of the broad, winding gully, between the scarped terraces on both sides. Here we came across the biggest tora of the place, 8.2 m. high and 31.4 m. in circumference at the base, standing on a table-topped or insular hill in the river-bed; it consisted of hard *débris* cemented together by dust and clay. On the top of the hill there were seven other more or less decayed *toras*, possibly forming in part the remains of a former fort-wall, though they may also have been ornamental *potajs*, similar to those which are found at the present day standing near important stations on the chief highways of East Turkestan, and which seem to have for their object to indicate the number of *li* to some other notable station in the vicinity. The bigger tower may possibly have served the same object as the pyramids which I discovered in 1896 beside the road from Korla to Jing-pen; these were merely »sign-posts» to mark the road or else outlook towers. Only one of the seven other towers preserved anything like its original form, namely a cube, crowned by a cupola, in a similar fashion to the usual Mohammedan gumbes or burial monument. Like the other six it was only about the height of an ordinary man.

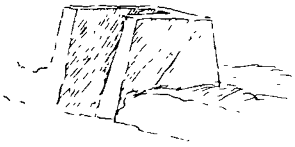
Fig. 33. THE SAME.

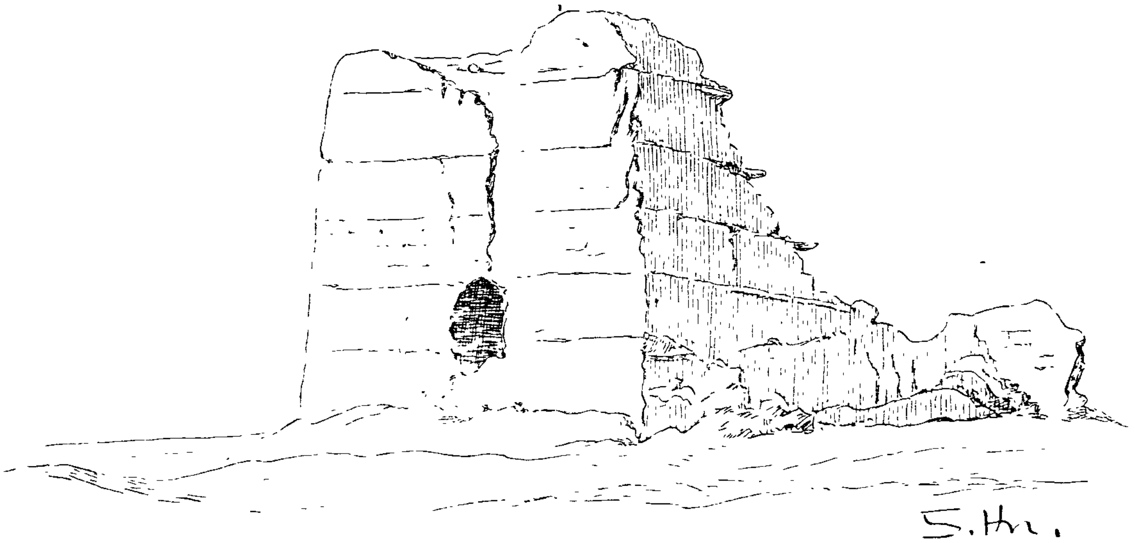

Fig. 34. CLAY PYRAMID NEAR KALTA.

After passing yet another ghuristan and about a score of graves, we came to the most interesting of the ruins that survive, namely a circular wall of precisely the same appearance as the one which I previously discovered at Merdek-schahr and at Ju-jing-pen. Its internal diameter amounts to 182 m., and the wall is 11 m. thick and 6.60 m. high. The four gates face respectively S. 80° W., N. 80° E.,

N. 10° W., and S. 10° E. In the middle is quite a small pyramid, but situated excentrically towards the north. The ground in the interior is furrowed by water-courses, the water having probably found its way in at a later period through the gates, and there are also a few tamarisks, each growing on a low mound. It is this circular wall to which the natives restrict the name of Kona-schahr or Eski-schahr. If now this wall had really been intended to defend a miniature town, one would expect to find some traces of the houses, seeing that this outer wall would obviously have protected them to some extent against wind and weather; yet of old houses there is not a trace to be seen. If it were originally a fort, one would suppose the four gates to be superfluous; one would have been sufficient. I am inclined therefore to look upon the inclosure as an ancient kan or caravanserai, or place of refuge, on the former highway from Lop-nor to Korla, and infer that the men whose duty it was to provide relays of horses, to forward the post, and keep guard generally, may have dwelt in tents within the inclosure, in the same way as the little Kirgis garrison of Ullugh-tschat dwell in jurts within their wall, though that is square, not circular. In that case the wall of the Kona-schahr will have served a double purpose, first to screen the tents against the violent storms of spring, and secondly to provide protection against any possible hostile attack. The eastern and western gates lie exactly across the old highway, and this probably ran right through the inclosure. The northern and southern gates stand astride of another important road, namely that from Turfan-karaul on the Kontsche-darja to Turfan, a route which was used not so very long ago by the beks of Turfan when they visited the Lop country to collect the tribute for the Chinese. Thus this road too no doubt crossed the interior of the inclosure, cutting the before-mentioned road at right angles. Without doubt another route ran from Turfan-karaul to Merdek-schahr, likewise an important station with a circular wall, it too fortified. Whatever purpose this circular wall of Jing-pen* may have served, it is certain that a great caravan highway ran past it, and as I shall show later on this great highway can have come from no other place except the town

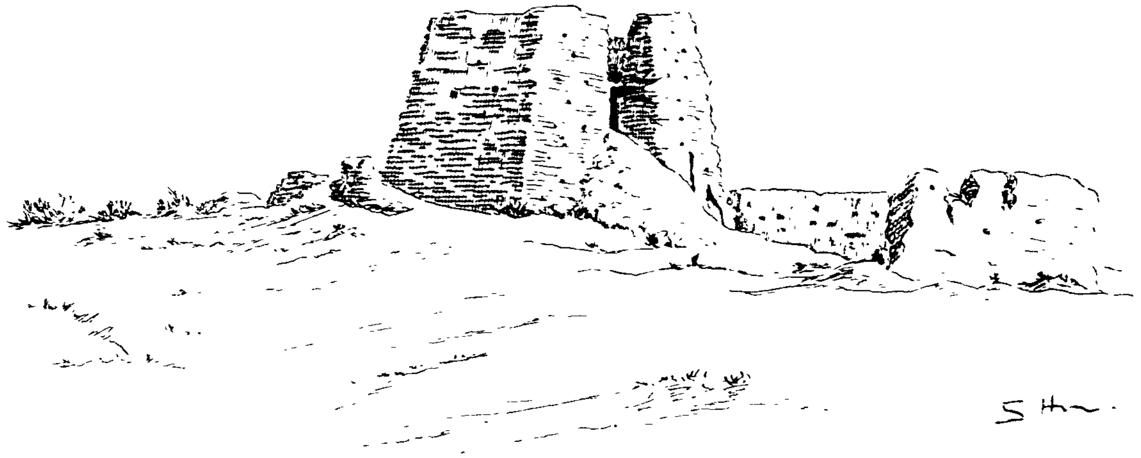

Fig. 35. KURGHANS BETWEEN KALTA AND JU-JING-PEN.

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* I have also heard this place called Jim-pen, but I have never heard applied to it the name which Kosloff gives it, namely Empen; this is plainly a corruption of Jim-pen.

of Lôu-lan, which I discovered on the northern shore of the Lop-nor lake. The ruins of Lôu-lan appear to be much older than those of Jing-pen; but on the other hand the latter place was inhabited and kept up for a much longer period than Lôu-lan. When the lake of Lop-nor dried up, Lôu-lan had to be abandoned; whereas Jing-pen was needed down to a considerably later period as a station on the road to Turfan.

Next we turned our steps towards the east-north-east, making for the new Chinese station-house of Jing-pen. We were one or two kilometers from the southern edge of the detritus-slope; it formed here a sharply defined terrace, as though its front had been washed away. Between it and us stretched hard, level ground, dotted with scrub and seamed with small watercourses. On our right we had tamarisk steppe, the bushes being both living and dead, and all standing on their characteristic mounds. A little farther away, towards the south, was a strip of thin toghrak forest, the trees being full-grown and vigorous in a few places only. My guides declared, that the forest accompanied the old river-bed, which they all agreed in calling the Kuruk-darja, and not Kum-darja, the name that Kosloff applies to it — a fact which is somewhat strange, for he had the same guide that I had, namely Abdu Rehim. The Lop-men were also aware of the existence of this river, but they did not know how far it continued towards the east. All they could say was, that it went as far as the district of Saj-tscheke, and that except in a few places it was accompanied throughout by poplar forest. At length the tamarisk-mounds came to an end, and the tamarisks grew directly out of the soft, level soil; there too kamisch was growing. The path crossed over a ravine, beside which were some young poplars. The Chinese caravanserai, called quite simply *örtäng* by the Mussulmans, was built shortly after 1890; but by 1898 it was again empty and deserted, for there is practically next to no traffic for Turfan. With asses it is generally reckoned a journey of 9 days from Jing-pen to Turfan, and with horses a journey of 6 days. Yet the only people who travel this route are merchants, and they use it but very seldom. It is indeed shorter than the route *viâ* Korla and Kara-schahr; but the latter route is preferred because it leads through none but inhabited tracts, where both man and beast are able to procure all they need for their sustenance. By pure chance we fell in, on the afternoon of 12th March, with a little caravan of 4 merchants, who had just arrived at Jing-pen from Turfan. From them I gleaned the following information. They were inhabitants of Tschertschen, and more than a month earlier had passed along this same route on their way to Turfan, their object being to buy, for Chinese silver, asses, mules, porcelain, and various other Chinese commodities, which they intended to sell again in Tschertschen. They expected it would take them yet another 25 days to reach home. They had left Turfan ten days previously, and had encamped at Budschentu, Atschik-bulak, Ärpischme, Singer, a spring without a name, Asghan-bulak, Toghrak-bulak, and Jing-pen. At Budschentu and Singer they had rested for over a day at each place. Beween Turfan and Singer there was a good deal of snow on the ground; indeed there had been quite heavy falls of snow in the region of Turfan that winter; but south of Singer there had been none. For 35 days the entire route north of Jing-pen had been buried under snow, and it had snowed several days whilst these people were on the road.

The station-house of Jing-pen stands on a terrace, 3 m. high. Immediately south of it is what at the first glance looks like a long, narrow marsh, entirely overgrown with thick kamisch, except in places where the open water shows. The water was only frozen along the shores. Wild-geese and wild-duck frequent it, and there were also partridges. As the water was slightly salt, a well, 0.60 m. deep, had been dug at the side of the marsh, and fresh water kept bubbling up at the bottom so freely that the well was full up to the level of the water in the marsh; its temperature was 9°.1 C.

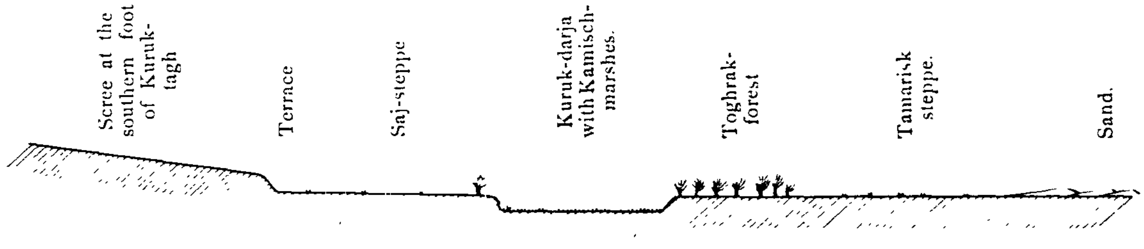
Scree at the southern foot of Kuruk-tagh
Terrace
Saj-steppe
Kuruk-darja with Kamisch-marshes.
Toghrak-forest
Tamarisk steppe.
Sand.

Fig. 36.

But a closer investigation revealed the fact, that this was not merely a marsh pure and simple, but the bed of an old river, in fact a part of the Kuruk-darja. For on the south it is again bordered by another terrace presenting the same appearance as the terrace on the north; and on both alike there are numerous poplars growing in clumps and groves. But immediately below the station-house the right bank, except for a few scattered tamarisks, is quite bare. Farther to the south there is said to be a narrow belt of dunes, crossed by the road to Tikenlik; on this last, in S. 12° W., we could see a potaj, or road-pyramid.

The accompanying sketch-map of the immediate vicinity of Jing-pen makes it perfectly evident, that this elongated marsh between the parallel terraces cannot very well be anything else except an actual river-loop. Not only is it extraordinarily well preserved, but it possesses all the usual qualities of a river-loop, being contained between distinctly marked erosion terraces, which are crowned, especially at the sharp bends, with forest. Farther east the bed of the Kuruk-darja is immeasurably more broken down and filled up, and it is so dry that the vegetation beside it died out long ago. Hence the impression is irresistibly forced upon one, that the Jing-pen portion of the river carried water at a much later period; perhaps a branch bifurcating from the Kontsche-darja may have penetrated up the upper part of the Kuruk-darja as far as Jing-pen. At the present time however no such stream would seem to flow that way, even in times of exceptional high water.* The water which we observed south of the station-house is derived from fresh springs, and gravitates naturally into the hollow, where it becomes stationary, and turns salt. The springs appear to be fed by the Budschentu-bulak, the brook from which comes to light again here; they, like it, yield a constant supply.

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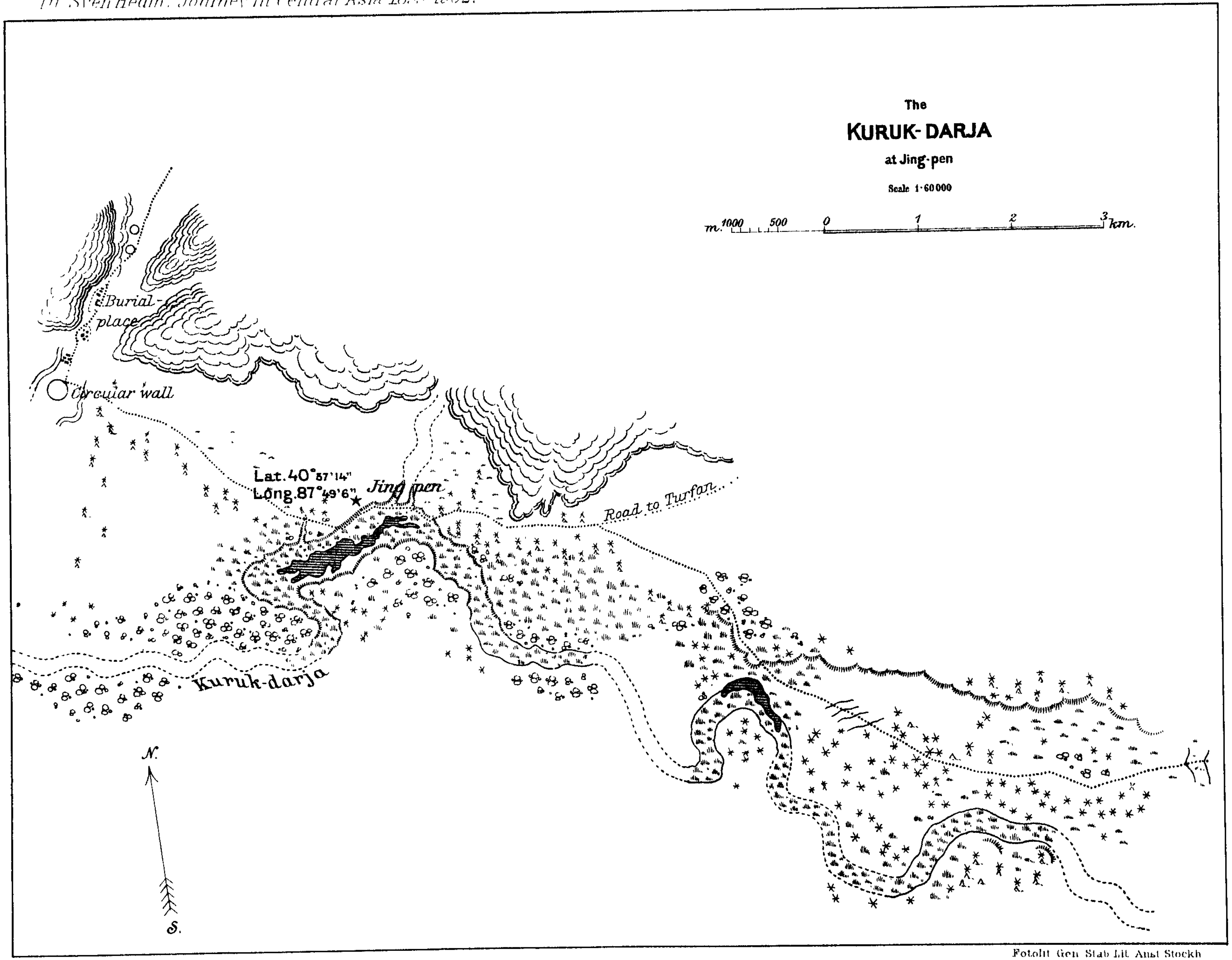
* Kosloff says, »At Empen there still survives an old river (*ilek*), which, according to the natives, is maintained during the summer by water that flows down the watercourses issuing out of the Kuruk-tagh, but for the most part it is supplied by springs situated not very far away. In this district, the vegetation which grows beside the lake-like arm of the river — a survival from ancient times — is precisely like that at Turfan-karaul.« (*Lop-nor*, p. 56).



The
**KURUK-DARJA**
at Jing-pen
Scale 1:60000

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Strangely enough, on both the 11th and 12th March, there was a pretty brisk breeze, blowing at the rate of as much as 8 m. in the second. This brought with it an inconceivably thick dust-haze; indeed the entire atmosphere was loaded with dust, so that we could not see more than two or three hundred meters ahead. It also raised the temperature to 21°.4 C. at 1 p. m. on 12th March. This rise was manifestly caused by the wind, for no sooner did the wind veer round to the east than the thermometer dropped quickly — and a big drop.

Certain particulars which I gleaned about the country between Jing-pen and Turfan are worth recording. The route between these two towns passes through the following places: — (1) Toghrak-bulak, situated amongst the low foot-hills of the Kuruk-tagh; there poplars and kamisch grow around a freshwater pool. (2) Asghan-bulak, situated in a tolerably open locality, though there are mountains round it at some distance away. (3) Singer, which is shut in by mountains not very far off on the west and south, though on the other sides it is open, except for slight hills. Here dwells a *karaultschi*, or »watchman», appointed by the amban of Dural; his principal duty is to keep an eye upon and arrest the *churdschas*, i. e. poor people whom the Chinese compel to cultivate the fields at the new settlements they make. West of Singer lie the mountain-ranges of Schi-da-sen (the Great Stone Mountains) near Asghan and Dun-da-sen (the Great Eastern Mountains), the latter being the eastern continuation of the former. The Schi-da-sen is reported to be a range of some magnitude, abounding in springs, pasture-grounds, and vegetation. On the contrary, the range of Mo-chur-sen (Miserable Dry Mountains), which lies to the south of it, is insignificant, barren, and desolate. (4) Pasa Begning-bulaghi, with salt water, and some grazing and tamarisks. (5) Usun-bulak, a kamisch-grown saline lake surrounded by tamarisk steppe. (6) A desert tract, in which the traveller encamps wherever he pleases. This tract extends to (7) Atschik-bulak. (8) Budschentu, where Mongols formerly dwelt; east of it is a large lake called Ajdin-köl, and east of that again some ruins known as Hassaj-schahr, deriving their name from a former inhabitant. (9) Turfan.

Between Budschentu and Da-dung there are extensive marshes. At Usun-bulak the road divides, a branch leading thence to Atschik-bulak (not the spring of this name just mentioned, — *it* lies a day's journey farther to the west), thence to Tatlik-bulak near Hassaj-schahr, and so on to Luktschin. At Är-pischme near Usun-bulak an attempt was made in the time of Jakub Bek to establish a Mohamedan colony. West of Usun-bulak is a spring called Örkäsch, and between the first-named and Atschik-bulak lies Egertschi. Half-a-day's journey east of Usun-bulak is Basch-bulak. The spring of Tarka is situated not far west of Är-pischme. The following topographical names were given to me as being connected with the Örtäng-jol, or »post-road», beyond Asghan-bulak: — Tschen-tschang, called by the Mussulmans Korghaschun-keni, or the Lead Mines, and situated east of Mo-chur-sen. Dscho-bi-sen is a high mountain on the west of the road, almost south-west of Tschen-tschang, where about 30 people — Tungans, Mongols, Chinese, and Mohamedans — are said to grow wheat. At Po-dschun-sa there are an örtäng, ruins, a tora, and five men, who also grow wheat. Gen-so-chola is a deserted station. At Schor-bulak there is an örtäng. Two other names along this same route are Üschme-däng and Aghir-bulak.

North of the Kuruk-tagh a road runs west from Singer to the *davan*, or »pass», of Suget-bulak, passing on the way Tallik; Tschong-aghis, where there is usually a pool of rain-water; Lo-tschen; Da-so-cho; and Davan, which is reached on the third day. Another route leads from Gen-so-chola, *viâ* Toghrak-bulak and Uschak-tal, to Kara-schahr; this is stated to traverse good and relatively level ground, and not to cross over a single pass. Another route leads from Po-dschun-sa *viâ* Sin-sen-schi and the same Toghrak-bulak to Uschak-tal. The frequent occurrence of the name Toghrak-bulak would seem to indicate that poplars are by no means rare in these mountainous regions. The names Atschik-bulak and Schor-bulak suggest that the springs are often salt.

The following list of names, drawn from Kosloff's account of his journey, proves that my guide Abdu Rehim was particularly trustworthy, and that his information may be relied upon, even when, as later on, I was compelled to trust to him alone. On another occasion I subsequently had an opportunity to check the information he gave me, and found it to be exceptionally accurate. With a few omissions, the names recorded by Kosloff are as follows: — Pasa Bekning-bulak, Usun-bulak, Julghun-tuse, Assa-schahri, Atschik-bulak, Arpischme (Är-pischme), Kisil-sinir, Dundiosen, Muchursejn, Basch-toghrak, Bodschante (salt-lake, situated about the middle of the Luktschin depression), Schor-bulak, Igertschi-tagh (Egertschi), Gensocholo, Uschak-tal, Kisil-tagh, Podschunsa. Most of these names agree with those which were given to me. In some cases violence has been done to their orthography, but even then it is not difficult to identify them. Certain of the names given to me are absent in Kosloff's book; and no doubt there are several other districts in this part of the Kuruk-tagh that bear names. In a later chapter (XIX) I shall, in another connection, reproduce extracts from Kosloff's description of this part of the Kuruk-tagh.

One portion of the same traveller's account of the region around Jing-pen is possessed of such great interest, and throws so much light upon the geographical and hydrographical changes which have taken, and are taking, place in the northern part of the Lop country, that I cannot pass it over in this connection. During the course of the winter of 1893—94 Kosloff travelled from Jing-pen to Turfan-karaul on the Kontsche-darja. On the sketch-map that accompanies his discussion of the Lop-nor we find a »dry river-bed» entered immediately south of Jing-pen. I have already briefly cited, in the first chapter of the present volume, Kosloff's description of this river-bed at »Empen». In *Lop-nor* he writes thus with regard to it: »After we had left the belt of vegetation at Empen behind us, we came to a »dead» river-bed, presenting at first the appearance of a wide stretch of saline soil, and then gradually assuming the aspect of a trough-like channel extending south. Scattered about the numerous windings of the latter there are a goodly number of dead toghrak stems, several of them still standing upright, others half buried in the sand. Indeed the »dead» hollow is likewise filled with sand, the biggest dunes having piled themselves up in proximity to the belt of living vegetation on the bank. On our way we crossed a belt of sandy barkhans, which extended north-west in the shape of a short and rather narrow (10 versts at most) wedge, while to the east-south-east the sandy desert extended as far as we were able to see.»*

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* *Lop-nor*, pp. 56—57; also *Issvestija*, vol. XXXIV. I have already cited this passage in *Petermanns Mitteilungen*, Ergänzhft 131.

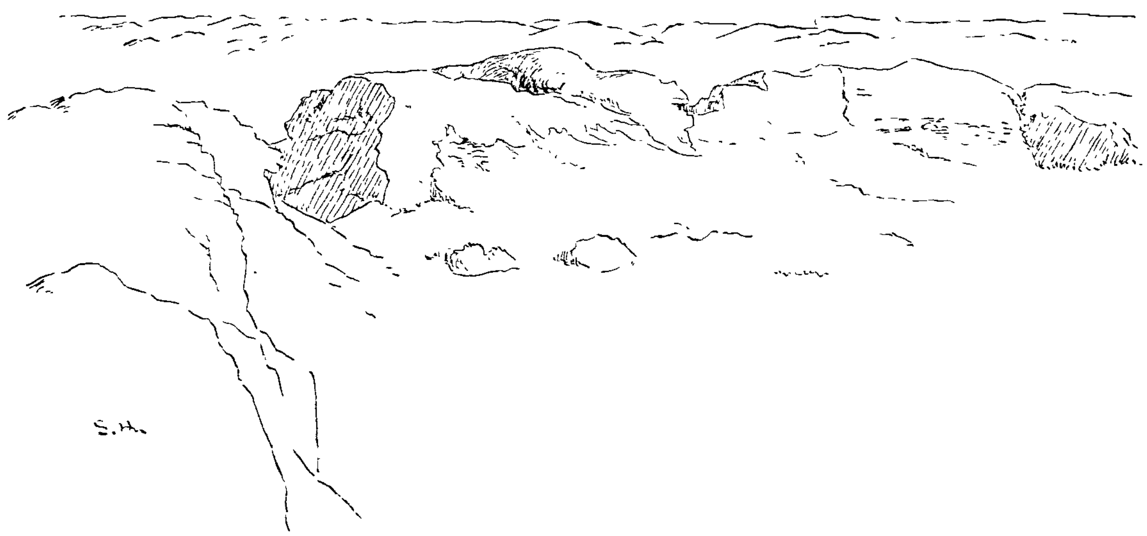

Fig. 37. PART OF THE CIRCULAR WALL OR OLD FORT AT JING-PEN, — AS DRAWN IN 1896

Before proceeding farther in the elucidation of the problem I have set myself, I must quote a couple of passages from my own work in *Petermanns Mitteilungen.** I have there described the last part of the day's march of the 26th March in the following words: »Später passieren wir eine alte Ringmauer. Sie hatte 200 m. inneren Durchmesser, ist 8 m. hoch und 10 bis 12 m. breit an der Basis, und mit vier Pforten im N., S., O., und W. versehen. Der ebene Boden im Inneren war jetzt mit Steppenpflanzen überwachsen; die Ruine wird Eski-schahr oder die alte Stadt genannt. Geht man eine kleine Strecke gegen NO. fort, so erreicht man einen Begräbnissplatz mit Grabmälern aus getrockneten Lehm, deren Orientierung nach Keble verrät dass sie Muselmanisch sind. Auf der Terrasse, welche wir immer linker Hand haben, sehen wir noch die Ruinen eines Turmes von ungewöhnlicher Form und die Spuren von Mauern and Häusern. Auch spricht das hier nicht besonders widerstandskräftige Material für ein wenig hohes Alter.

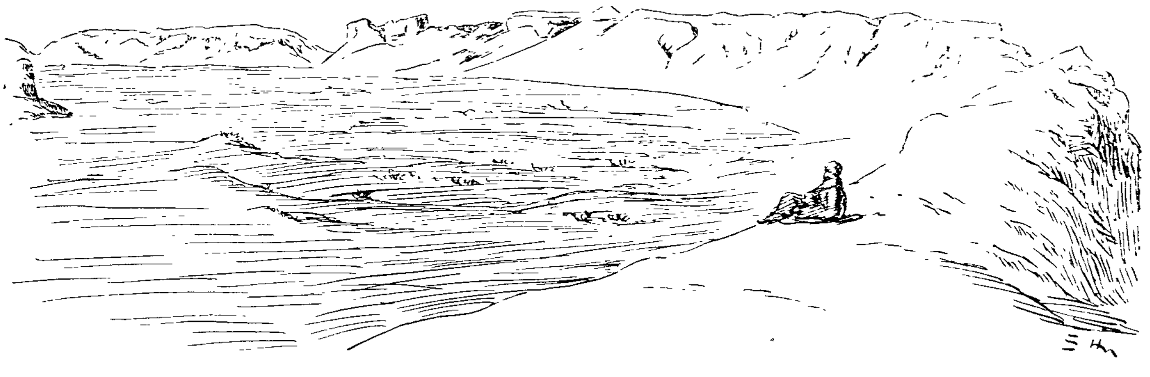

Fig. 38. PART OF THE OLD FORT OF JU-JING-PEN, AS DRAWN IN 1900.

Sonst war die Gegend vollkommen öde, keine Spur von Weg oder Menschen. Rechter Hand lassen wir einen Sumpf mit saltzhaltigen Wasser hinter uns, an dessen

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* Ergänzhft. 131, pp. 76 and 77.

Ufern Pappeln wachsen. Endlich erreichen wir das chinesische Stationshaus Ju-jing-pen; auch dieses ist auf einer niedrigen Terrasse gelegen; am Fusse desselben breitet sich ein ausgedehnter Sumpf aus, auf dessen weichem schwarzen Schlammboden seichtes salziges Wasser steht, sonst ist der Sumpf von ausserordentlich dichtem Schilf überwachsen.

Der Bach von Budschentu-bulak, dessen trockene Furche wir nicht weit von den Ruinen passierten, führt nach Regen gewöhnlich viel Wasser und bildet den obenerwähnten Sumpf in der Nähe der chinesichen Station.

Am 27ten März gingen wir nach SSW. am westlichen Ufer des kleinen halbmondförmigen Sumpfes und erreichten dann wieder ebene, harte Staubsteppe, wo Fragmente vom Lehmterrassen recht allgemein waren. Triebsand kommt vor und wird allmählich mächtiger, anfangs in zerstreuten Dünen von 1 m. Höhe, dann dichter, mehr zusammenhängend und bis 4 m. hoch. Vertrocknete Tamariskenwurzeln liegen hier und da, und die Kegel treten wieder auf. Diese keilförmige Wüstenstrecke ist nur ein schmaler Ausläufer des weiter östlich sich ausbreitenden grossen Sandes, und ihrem Charakter nach ähnelt sie der Wüste, welche wir zwischen dem Ugen-darja und Kontsche-darja gekreuzt hatten. Die steilen Abhänge der Dünen sind nach W. gerichtet. Der Ausläufer ist nur einige Kilometer breit und geht allmählich in Kamischsteppe über, welche sich bis zum Flusse erstreckt.»

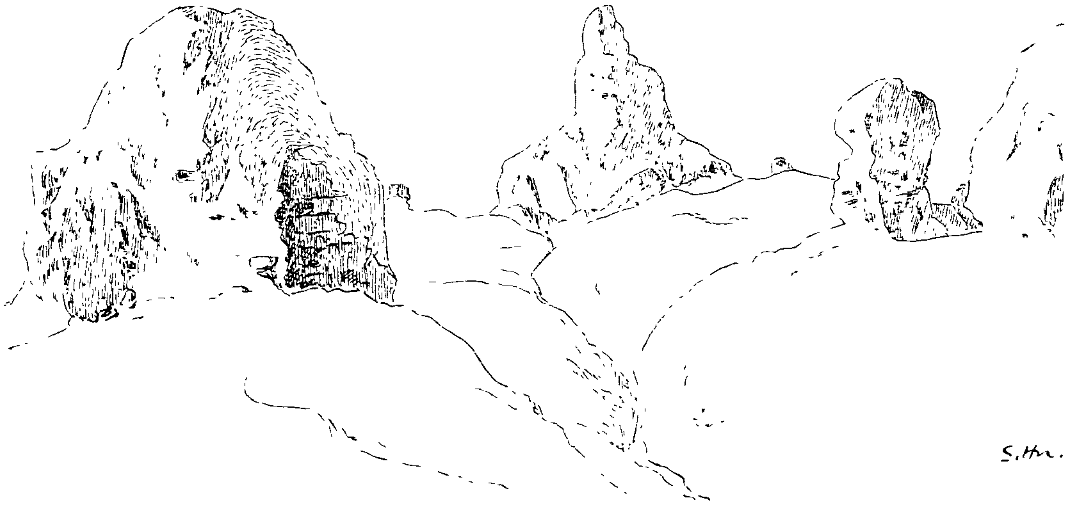

Fig. 39. THE RUINS OF JU-JING-PEN, AS DRAWN IN 1896.

From this we derive several important conclusions ready made. For one thing, we learn that the wedge-shaped belt of sandy desert along my route, mentioned by Kosloff, contracts still further, until just west of the same it thins out completely. Further, the fragments of the clay terraces which I saw on the steppe are possibly the remains of a river-bed now for the most part swept away by the wind; in this case it would form the upper part of the sanded up river-bed which Kosloff speaks of as being to the south of Jing-pen. Upon reading again, after an interval of seven years, my own description of this Ju-jing-pen I was of course sure to think that it was identical with the Jing-pen of 1900, although I approached the river-bed in question from two different directions. As the reader will readily see, the two descriptions agree even to the minutest details. In both cases there is a circular wall of almost exactly the same dimensions, pierced by four gates facing the four quarters of the compass. North-east of each circular wall there exists a little burial-ground, with ruins of a tower and of walls, backed on the north by a terrace, the extreme outlying portion of the detritus scree. On the south there exists in both cases alike a kamisch marsh, with saline water, and poplars growing on its margins; and in both cases there is, again, a Chinese station-house on the north side. Finally, in both cases the marsh is entered by erosion gullies coming from the Budschentu-bulak.

Nevertheless upon comparing my materials with those of Kosloff, I was tempted to think that the two places I visited were not identical. In so far as the natural characteristics of the surface are concerned, it ought to occasion no surprise to find there is such a close resemblance between the two, for the old river-bed extends east from the Kontsche-darja, and everything seems to indicate that for a considerable part of its course, at all events from Jing-pen onwards, it exhibits the same character, being bordered by the same poplar-planted terraces, and having the same kamisch-grown marsh in its bottom — a marsh that is fed by springs which bubble up in what is probably the wide-reaching subterranean delta of the Budschentu-bulak. Nor should it occasion any surprise that the terraced edge of the *detritus* scree advances in both cases all the way to the river-bed; for in the sequel we shall find that it extends an incredibly long way east beside the Kuruk-darja. It was however a curious coincidence to find in both cases the same evidences, both new and old, of human agency. But, assuming that Kosloff's map was put together with the necessary degree of accuracy, it is easy from a comparison of his map with mine to ascertain that his Empen and my Ju-jing-pen lie at a considerable distance apart. From Ju-jing-pen it is barely 20 km. in a direction S. 35° W. to Turfan-karaul; Kosloff however has 40½ km. in a direction S. 60° W. to the same point. Hence both Kosloff's map in *Lop-nor* and mine in *Petermanns Mitteilungen* seem to be in agreement in making the distance between Ju-jing-pen and Jing-pen to be 22 km. That is to say, we seemed to have crossed the wedge of desert along a different route. Where I crossed it, the belt of sand was only 2, or at the most 3, km. broad; where Kosloff crossed it, it was 10 versts. The distance between the two stations, 22 km., is apparenlty, it is true, but a short day's march, and it would seem to be unnecessary to put up station-houses so close together; but the reason for doing so may have been, that just here alongside the old river-bed there existed fuel, grazing, and water in greater abundance than at any point farther on in the mountainous region of the Kuruk-tagh. Thus I almost felt obliged to believe in the existence of two routes between Turfan-karaul and Jing-pen: one along the northern bank of the old river-bed *via* the station-house of Ju-jing-pen, the other diagonally across the desert. The latter would be the one that was used by Kosloff, and has been entered by Dr. Hassenstein on my map in *Petermanns Mitteilungen* to the east of the route I followed in 1896. In fact Abdu Rehim told me, that along a more easterly route there are *nischans*, or «sign-posts», as well as three *gumbes*, for the purpose of indicating the road during the sandstorms.

Were my observations the only material available, I should not for one moment doubt that Ju-jing-pen is identical with Jing-pen, and that the difference in name is to be set down to the different pronunciation of Chinese topographical names by the Turkic natives. I travelled too rapidly through Ju-jing-pen in 1896. It was indeed inhabited by an *örtängtschi*, but I cannot now remember what the station-house looked like; otherwise that would afford something certain to start from. But the similarity between the notes I made in 1896 and those of the more accurate examination I made of Jing-pen in 1900 makes me very much inclined to regard Jing-pen and Ju-jing-pen as identically the same place, especially as on the latter occasion I heard no mention of a more westerly station-house. But Kosloff's map prevents me from being positive about the matter, seeing that the distance he assigns to the place from the Kontsche-darja is twice the distance I made it out to be; and I cannot conceive it possible he can have made such a mistake as this implies. Hence I am constrained to grant the possibility, that there may exist two stations, Jing-pen and Ju-jing-pen. situated on the left bank of the most western part of the Kuruk-darja, at respectively 40 and 20 km. distance from Turfan-karaul, and 22 km. from one another. In any case I must leave the question open, until the future shall decide after I have made a fresh visit to the spot.

# CHAPTER III.

## THE KURUK-DARJA AND THE COUNTRY SOUTH OF THE KURUK-TAGH.

Kosloff gathers up the results of his own observations with regard to the Kuruk-darja (i. e. Kum-darja) in the following passage: — »Thus at some former time the Kontsche-darja flowed in another, more easterly channel than its existing bed. As time went on, the river gradually inclined more and more towards the south; in proof of which we have the old river-beds south of the Kum-darja, between that river and the existing Kontsche-darja. After the Kontsche-darja had diverged 40° to 45° from its original direction, the river settled down into the bed by which it now travels to Ajrilghan, where it unites with the Tarim. At any rate, at that distant period the Kontsche-darja flowed, as it flows to-day, towards the lowest part of the desert, i. e. to Lop-nor. There was a time when the Lop-nor was unquestionably bigger than it is now, and extended much farther towards the north; its western shore coincided with the line Urten (Örtäng)-Abdal-Ajrilghan, while its southern shore-line was pretty much the same as it is at the present time.»*

On the whole this view agrees with my own, except that, for sufficiently good reasons, I consider that the Kuruk-darja was the principal artery of the whole of the Tarim system, and that the lake into which it discharged was situated solely in the northern part of the desert; but this question will be discussed lower down in a separate chapter. The »dry river-bed» south of Jing-pen is however of interest, for it proves that the Kuruk-darja did not change its position from east to south-east all at once, but did it step by step, and that the stream adhered no doubt to each successive new channel for at any rate a certain period. Ju-jing-pen or Jing-pen are situated just at the pivot upon which the river wheeled when it turned to the south-east. If we confine our attention to the upper limb of the angle, that is the southern one going down to Avullu-köl, we find that the angle is 30°; but if we push our observation as far as Tschigelik-uj, then the angle is 70°. The reason the southern river-bed, Kosloff's »dry river-bed», is less well preserved than that at Jing-pen is simply the fact that the latter contains spring-water. In point of actual fact the southern watercourse is the younger. In all probability there exist several other old river-beds in the angle between the two »limbs». It would be very interesting to explore that particular region and follow Kosloff's »dry river-bed» as far as it goes towards the south-east.

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* See *Lop-nor*, p. 57.

Whilst detailing the journeys of the following days I shall have abundant opportunity to study the Kuruk-darja, and its former course, and I will endeavour at the same time to convey an idea of the aspect of the country along the southern foot of the Kuruk-tagh. On 13th March, our first day from Jing-pen, we travelled mainly east. At first we kept to the old river-bed, having the lower terrace on our left and the marsh on the right (south). When the latter came to an end, we again climbed to the top of the terrace on that side, and for a time travelled along the usual road to Turfan. Both terraces are gapped by a couple of ravines coming from the north and issuing into the marsh. Traversing soft ground, plentifully dotted over with tamarisk-mounds, we at length came to a southward projection of the upper terrace. At the same time the river makes a parallel curve towards the south, and for a space disappears from sight, though its course is always traceable from the groups of toghraks which accompany it throughout. After the upper terrace, the existence of which we first detected at the ruins, has returned to its original direction, the surface becomes hard and level, and is strewn with small stones and coarse sand, and is practically barren. This brought us, without our being aware of it, up on to a middle terrace, the presence of which was however revealed by our having, at the next northward bend that the river made, to descend by a steep step, when we again found ourselves on the terrace which forms the northern scarped bank of the ancient stream. On the little promontory of the middle terrace there stands a clump of old and gnarled poplars, generally quite fresh and full of vitality, and measuring at the most 4.10 m. in circumference at the base. The river loop referred

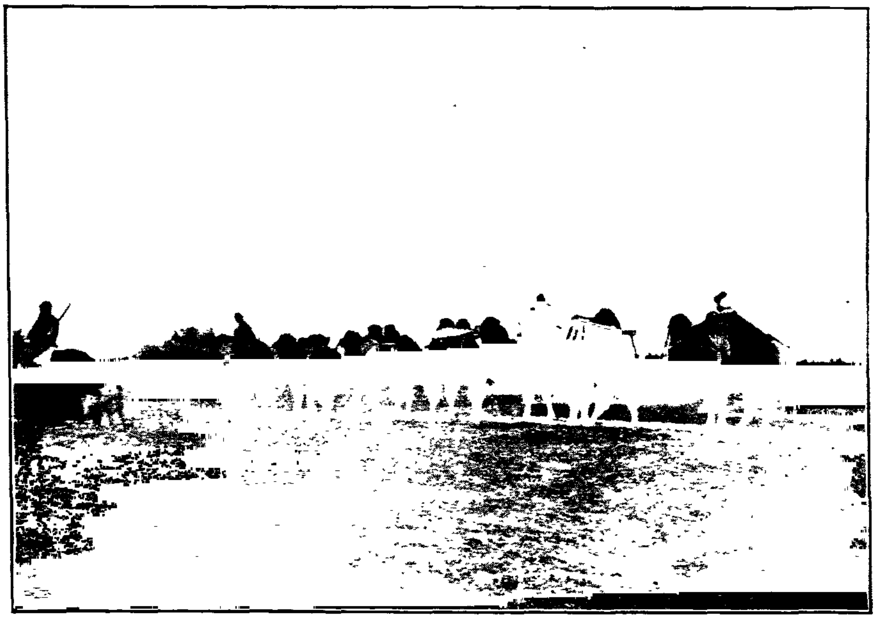

Fig. 40. THE COUNTRY BETWEEN KURUK-TAGH AND KURUK-DARJA EAST OF JING-PEN.

to is so distinct, and so extraordinarily well preserved, that it might very well be taken for a boldschemal abandoned only one or two years ago. On its bank there were however only two or three poplars. Its deepest part, on the outside, next the scarped bank on the longer periphery, was a crescentic pool, full of water, of precisely the same appearance as any loop quite recently deserted by the river. It contained no ice, but its water was a good deal salter than that in the bend at Jing-pen. There was also a flock of wild-duck on its banks. There can be no doubt that this loop is fed by freshwater springs, and has no connection whatever with the marsh at Jing-pen.

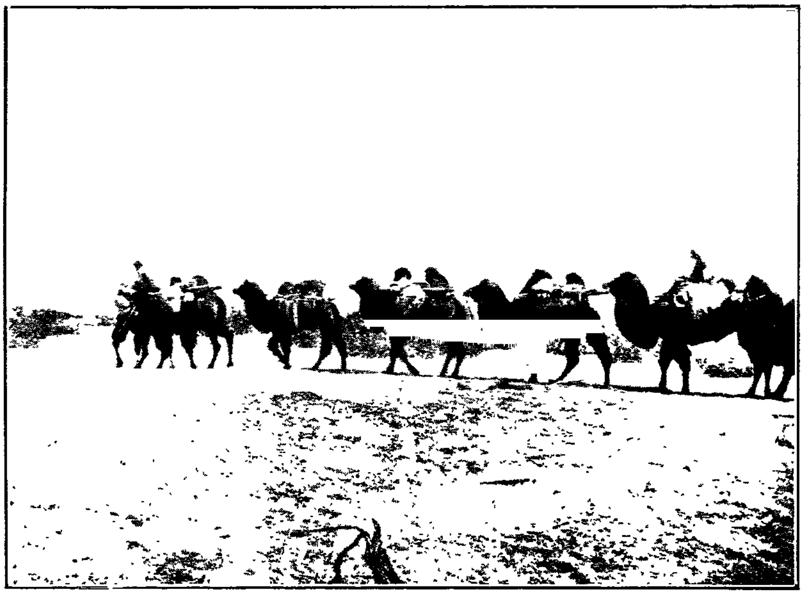

Fig. 41. THE COUNTRY BETWEEN KURUK-TAGH AND KURUK-DARJA EAST OF JING-PEN.

After that we travelled away from the edge of the middle terrace and at the same time left the river behind us, upon its making a fresh angle towards the south. Between the two the ground is hard schor, furrowed at intervals by gullies with a gravelly bottom, which only carry water for short periods. The middle of this intervening space is filled with forest (*kötäk*), that is toghrak trunks long dead and prostrate on the ground, with branches and roots of tamarisks. A few hundred meters farther south there are other toghrak stems still standing upright, and marking by their positions the course of the river. Once more we touched the river-bed, at a place where it did not contain a single drop of water, though it had plenty of luxuriant kamisch. The ground-water is therefore not very far down, a fact likewise indicated by the presence of a few living tamarisks and poplars. We again caught a glimpse of the outline of the middle terrace looming through the dust-haze to the north. At this point the river makes a much more pronounced inclination towards the south. Here too there is a labyrinth of mounds, bearing some of them living tamarisks, others dead ones, and threaded by several small gullies, each about a meter deep and with sharp-cut, distinctly marked edges. They are an indication that in this tract, which lies a good deal nearer to the mountains than the Kontsche-darja does, the rain-torrents are able to reach down to the lowlands, and enter the former river-bed. The gullies of which I have just spoken lie undoubtedly along the line of continuation of some more noteworthy transverse valley or glen in the Kuruk-tagh. They have in course of time brought down with them vast quantities of solid matter, so that, as I have already suggested, the augmentation and spread of the detritus slope have at all events encroached upon the left bank and affected the position of the river as a whole. Immediately beyond these gullies, the Kuruk-darja bends so far to the south that it, together with its poplars, disappears completely out of sight. From the perfectly level expanses of barren soil, as hard as asphalt, and the patches of yellow argillaceous silt it is perfectly evident that the water spreads out and forms shallow lakes, which must evaporate and dry up very swiftly, leaving behind them the silt as a sediment. One of these expanses was pretty large, and afforded excellent ground to ride over.

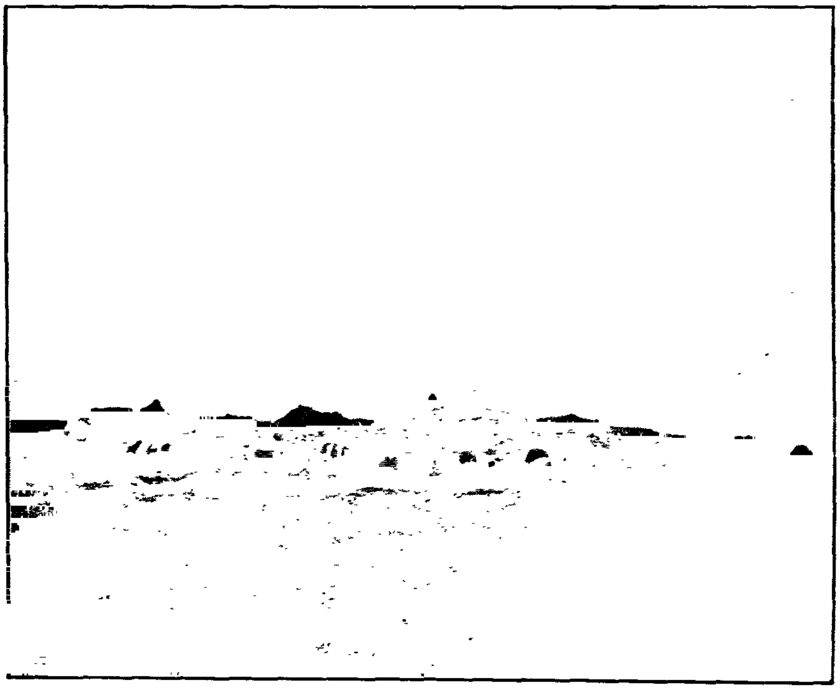

Fig. 42. TERRACE FORMATIONS AT THE SOUTH FOOT OF THE KURUK-TAGH.

Then we once more approached the middle terrace, which possibly coalesces with the upper terrace to form a yet larger one. This last is frequently pierced by sluice-like openings, through which the rain-torrents pour down into the Kuruk-darja. At one or two kilometers' distance we again perceived, towards the north, the extreme outliers of the Kuruk-tagh, in the form of low, rounded heights. For a short space we kept quite close to the edge of the terrace. In two or three of the openings already alluded to its sides were perfectly perpendicular, and consisted throughout of fine yellow clay, capped only by a superficial layer of fine gravel. To the south the clay surface was furrowed by innumerable gullies eroded by the wind, and separated from each other by *jardangs*, or »ridges», about 2 m. in height. Amongst these the usual tamarisk-mounds still continued to appear, though many of them were quite bare, their bushes having been destroyed by the wind and the abrasive action of the sand; though their roots probably in most cases remain, having been protected by the mounds themselves. A little way south of our course we observed a strip of standing toghraks, and beyond them we caught faint glimpses of a few low sand-dunes. These were the first we had seen that day, the nearest previous approach to dunes being slight accumulations of sand in two or three sheltered spots. Yet, owing to the haze which was now become general, we were unable to see to any great distance; besides, under such conditions it is easy to deceive oneself as to both the distance and the size of objects. The blurring of their outlines leads you to think them farther away than they actually are, and this again deceives you as to their size.

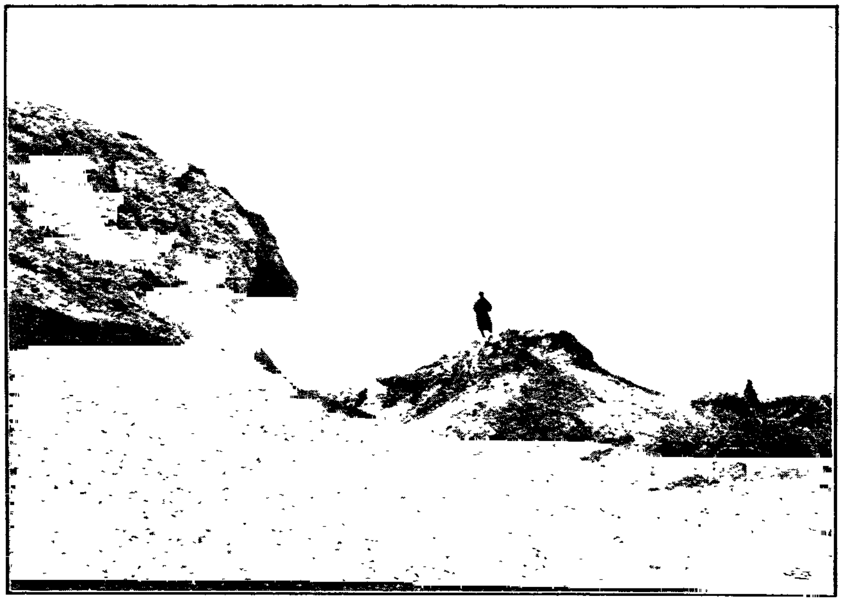

Fig. 43. CLAY TERRACE AT THE SOUTH FOOT OF THE KURUK-TAGH.

About two o'clock a tempest burst upon us from the east-north-east, occasioning complete twilight, and preventing us from seeing farther than 20 or 30 m. away. After a while the wind changed to the north-east. Close to the earth it blew with a velocity of 18.1 m. in the second; but when the anemometer was placed on the top of a mound only 2 m. high it registered a velocity of 26.6 m. in the second. The tempest continued all the evening and all night, and did not slacken until the following morning. It lowered the temperature to a minimum of — 7.1° C. If surprise was occasioned by the observation I made on this my first visit to the Lop Desert, that I failed to perceive any drift-sand, we have in this tempest a fairly natural explanation of the reason for it. The materials of which the sandy desert is composed are obtained from the products of disintegration of the encircling mountains, and here we were exactly at the foot of one of the encircling ranges, the source and origin of the drift-sand. But the sand which is carried thence by the wind out into the desert does not get an opportunity to gather into dunes until after it has travelled a long distance to the south-west, for that which collects as the result of weathering along the foot of the mountains is blown away by the first storm that sets in. How considerable the quantities of sand are which are put in motion by a storm of this description can readily be proved. You have only to crouch down with your back to the wind, and you are at once well-nigh suffocated by the amount of dust and sand that accumulates in the eddy formed by the shelter of your own body. And when you at length manage to get up a tent behind the screen of a tamarisk-cone, its canvas is penetrated by such an excess of sand that every object within the tent is speedily covered with a thin, even coating. And so violent is the wind that small fragments of *kötäk*, broken pieces of steppe scrub, and finer particles of gravel as big as peas are volleyed before it like projectiles. Everything of a loose or transportable character, that, before the outbreak of such a storm, happens to be lying scattered over either the gently sloping gravelly scree, the saj, or the level clay desert, is inevitably set in motion and driven bodily towards the south-west, where all this material finally collects and forms dunes. The finer particles however continue their journey still farther in the same direction. In consequence of this the country we are just now travelling through is swept clean and bare, and it is only in two or three places, where the circumstances have been specially favourable, that a little sand has accumulated. As a rule therefore it may be affirmed, that this part of the Lop Desert is free from dunes.

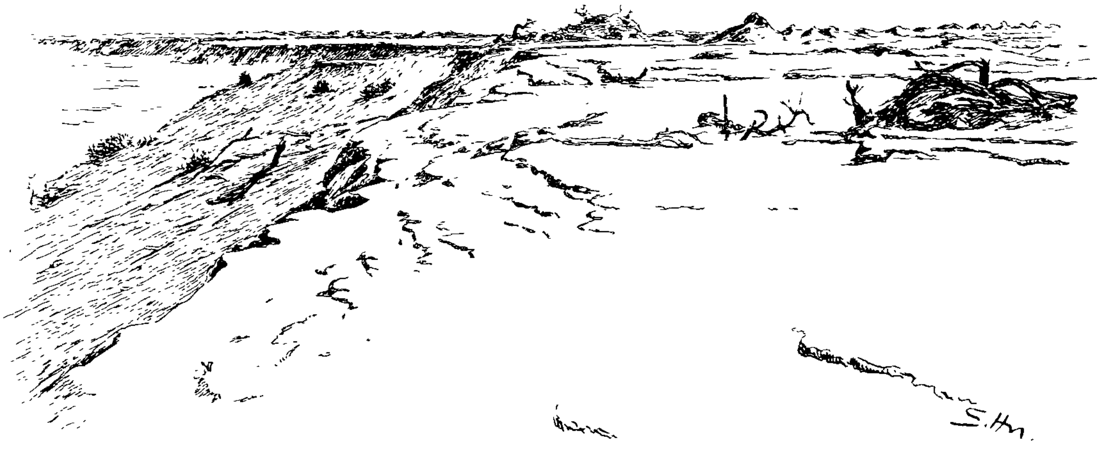

Fig. 44. RIGHT BANK OF THE KURUK-DARJA.

On 14th March we twice crossed the Kuruk-darja immediately south-east of our camp; and contrary to expectation, the soft dust which lines its bottom was moist on the surface, not indeed to any very noticeable extent, still sufficient to keep the tamarisks and kamisch fresh. Dead forest, which, following the practice of the natives, I shall henceforward call *kötäk*, was abundant everywhere, in some places the trees still standing upright, in other places lying prostrate on the ground. It was interesting to find *jigde* (*Eleagnus*) amongst them, for this bush only thrives near fresh water — lakes and rivers — and dies as soon as these dry up. Thus jigde is far more particular with regard to water than the toghrak and the kamisch, which both resist destruction for a pretty long time after the disappearance of the lake or river beside which they have grown up. At the second place where we crossed it the Kuruk-darja was full of prostrate *kötäk*, much of it half buried in the ground; very likely this was ancient drift-wood. Here there was also a more extensive area of moist dust, seemingly the bottom of a former lake. Its moist condition, like that of the river, is due to its proximity to the mountains; for no doubt rain-water still collects sometimes in these old depressions.

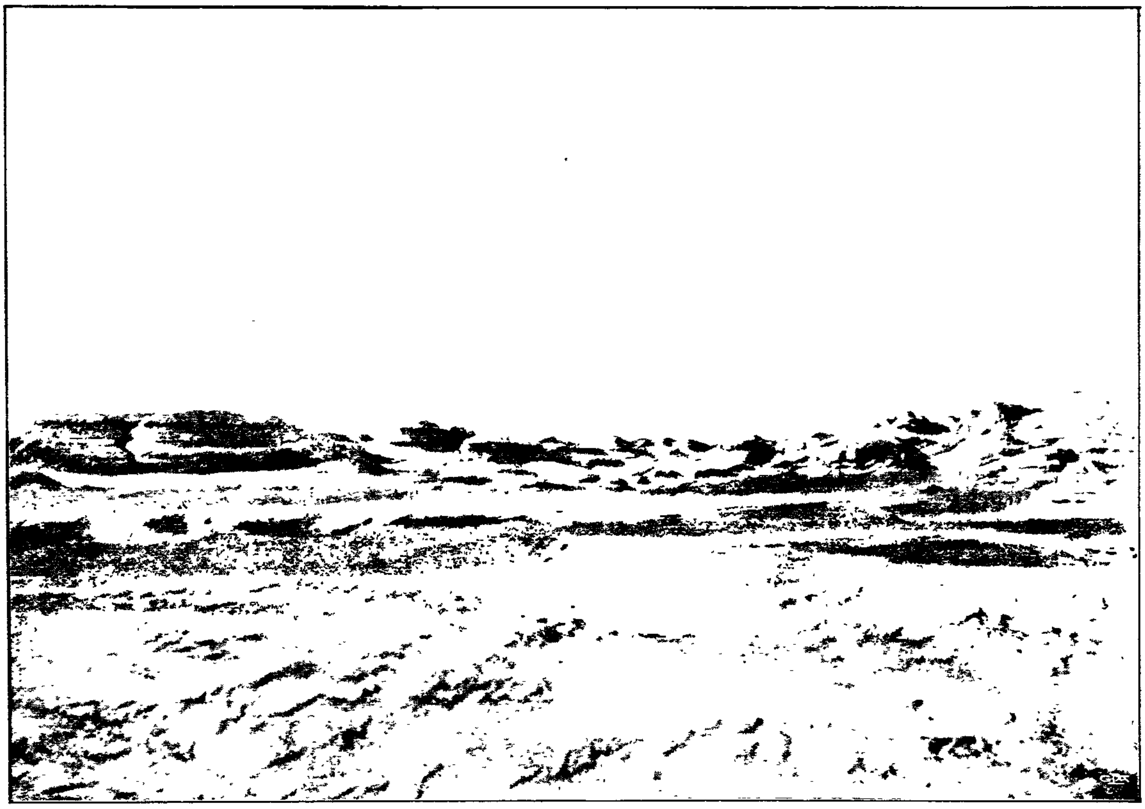

Fig. 45. A LABYRINTH OF CLAY-TERRACES.

After that our path ran for some distance through a labyrinth of clay terraces and ridges, where no distinct river-bed could be traced. Possibly these several terraces mark the successive shore-lines of a lake that dried up step by step and left them behind. They appeared to extend southwards right away to the horizon, the country being in that direction everywhere perfectly level, except for an occasional low detached dune. After that we had the river-bed on our left, its course being indicated by a line of upright kötäk. Beyond it were the rounded heights of the Kuruk-tagh, though they nowhere exhibited such imposing dimensions as at Budschentu-bulak. Farther on we crossed the Kuruk-darja several times, its bed being very distinctly marked and its loops in point of form strikingly reminiscent of the present lower Tarim. Kötäk was often extraordinarily plentiful, mostly in the form of old poplars of considerable size lying on the ground, though these never grew to such a considerable size as the living poplars we had seen; their circumference generally measured up to 1 m. The trees still standing upright always have thin and slender trunks, presenting a remarkable likeness to dry, grey telegraph-poles. As a general rule, the timber of the standing kötäk would seem to be harder and more resistent than that of the kötäk lying on the ground, for the latter is extremely soft, as well as cracked. To judge from its dimensions, the standing kötäk is the younger; the older trees, having the softer timber, and their vitality being more spent, have consequently fallen. When compared with the living forest which we saw growing beside several of the river-branches of the existing Tarim, the dead forest beside the Kuruk-darja gives the impression of having at no time passed beyond a medium age. In this respect however it is easy to be deceived; for there can be no doubt, that during the period in which it flowed along the foot of the mountains, the Kuruk-darja, like the existing Tarim, shifted its channel several times. The winding gullies and «corridors» of this dry yellow clay region, in which on several occasions we got entangled, are probably parts of the former course of the river, either arms into which it split or the different beds between which the river flitted to and fro. Under these circumstances the forest did not reach full maturity before it was deserted by the river. But it is much more likely, that this old dried forest has suffered through the effects of the atmospheric forces, and the abrasive and planing action of the wind, in consequence of which the trees are now smaller than they were when alive. It is the upright trees which are especially exposed to the abrasive action of the wind-driven drift-sand, and this is perhaps the sole cause of their being thinner than the trees that lie on the ground. Indeed, it is altogether an astonishing thing, that they are able to maintain their upright position at all. Seeing that they must be at least fifteen hundred years old, one would expect that the countless

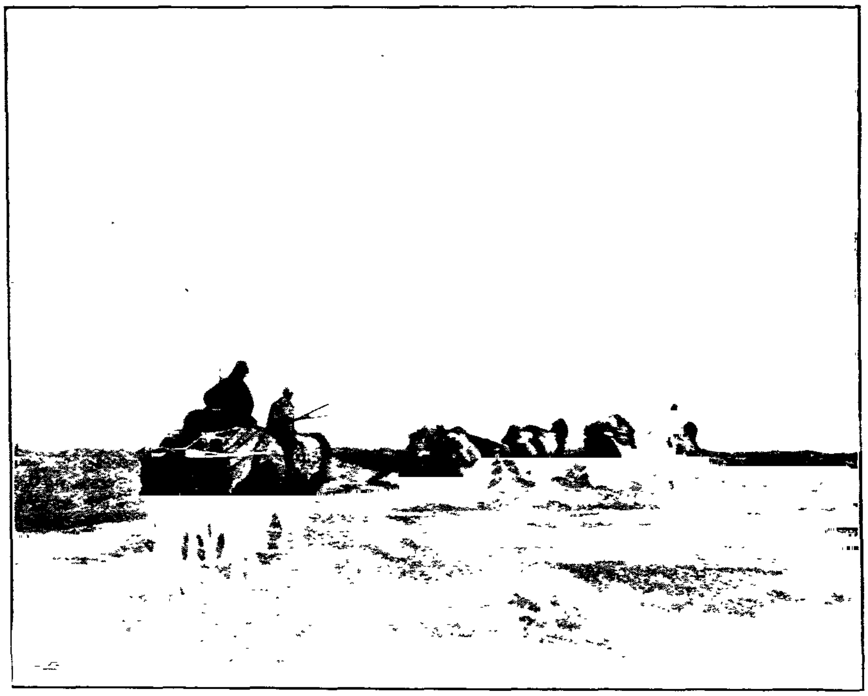

Fig. 46. PART OF THE DESERT NORTH OF THE KURUK-DARJA.

storms of drift-sand which have swept over them would have filed right through them, or some time or other have broken them to pieces. Their power of resistance is thus evidently very great; but they are strongly impregnated with sand, which possibly helps to retard the effects of corrasion, and so they still continue to stand upright on their roots, which have hardened in the dry clay soil. This dry kötäk burns with extraordinary ease, but sinks when put into water.

Sometimes we crossed over stretches of soft powdery soil, the surface of which was littered with fine gravel; in appearance this soil looks like the gravelly scree or the saj (though this last is hard), though the gravel does not contribute to make the ground firm. In such places as this jardangs, or clay ridges, are entirely absent; but there are a few scattered mounds of dead tamarisks; and the dunes on the south are not very far away.

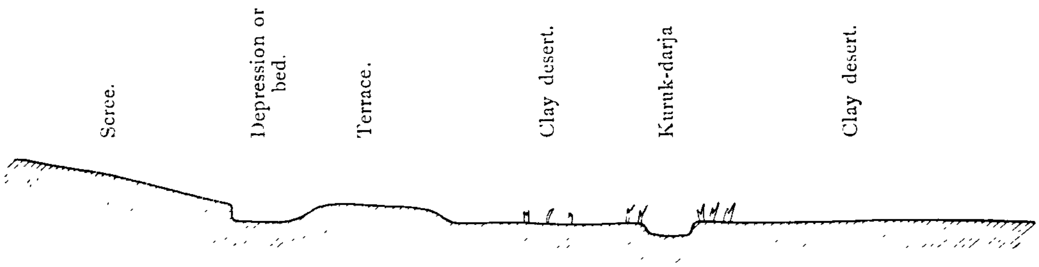

Fig. 47. THE DEPRESSION BETWEEN THE TWO TERRACES AND THE KURUK-DARJA.

There was an abundance of dead forest on the banks of the next bend of the river, many of the trees being of a considerable height. The bottom of the channel was strewn with coarse sand and gravel. Then came another tract of jardangs, a formation that is extremely difficult for camels. It was very seldom that we were able to proceed far in one and the same gully; generally it was up and down, up and down, first up over one clay terrace and then down into the next gully, and so on unceasingly. Some of the broken ridges stood up like tables and platforms, their edges having been eaten away by the wind and their feet cumbered with blocks of clay that toppled down when the terrace wall became too far undermined. Already we made the observation, that the gullies with which the ground is furrowed run predominantly in the direction of the prevailing wind.

When the surface became all too difficult we preferred to travel along the edge of the saj terrace, and this led us to the south-east. It also afforded us a first-rate view of the country to the south. Every now and again we caught a glimpse of the windings of the river-bed through the labyrinth of the jardangs, and above the latter rose the grey trunks of the dead trees and the equally grey tamarisk-mounds. The surface of the saj is hard, and thinly sprinkled with gravel. Otherwise it is composed of the same fine-grained yellow clay as that of the level desert below; this we were easily able to see in the steep sides of the ravines. In the same places we were also able to ascertain the dip of the loess-like clay stratum, namely 17° towards S. 70° W. The stratification of the clay desert is just as evident, although its inclination is a trifle towards the south-west. Except for a very occasional tamarisk, the saj is almost barren. At the back of the nearest foot-hills we could perceive a dark and not very distinct ridge, known as Tschartschak, or the Mountain of the Wearied Ones, a name derived from the fact that a detachment of Chinese troops went astray here and nearly perished of thirst. It was in this locality that we first perceived the track of the wild camel.

The portion of the saj on which we were marching forms an independent terrace, being separated from the edge of the detritus slope by a depression, fenced in on the south-east by a very distinctly marked, almost vertical, escarpment. The terrace on which we were proceeding, although sharply defined on each side, slopes away gradually towards the north-east and south-west, while its own direction is south-east. It also forms an evident boundary-line for the vegetation. To the north-east of it the country is absolutely barren, whereas to the south-west there is an abundance of kötäk, proving that the plant-life here was formerly luxuriant. One feature of the landscape catches the eye at once, namely the depression I have just mentioned between the two clay terraces. Its bottom is sterile, and for as long as we followed it, it ran pretty straight towards the south-east. It is very difficult to arrive at any other conclusion than that this must be a former bed of the Kuruk-darja, for in appearance it bears a striking resemblance to an eroded channel, except for the fact of its running in such a straight line. The suggestion that its origin can in any way be due to wind-erosion is entirely out of the question, for the prevailing wind cuts it at right angles.

Going down from the clay terrace, we encamped on the left side of the bed of the Kuruk-darja. From that point the nearest spring was that of Jigde-bulak, lying behind the Tschartschak to the north. On the way thither kamisch occurs in one place, not far from the saj; but there is no water. Hence at our Camp No. VII there was an absence of everything except kötäk.

As during the course of the day's march we frequently found the bed of the Kuruk-darja indistinct, or rather interrupted at intervals, my Lop-men, who are shrewd and skilful in the interpretation of both new and old hydrographical relations, were of opinion that the river had here flowed through a series of small lakes, in the same way as certain parts of the Tarim do below Jangi-köl. This is not unlikely; but it is also likely that certain portions of the channel have become more obliterated than others through the filing and planing action of the wind. By way of throwing light upon the country to the south, I may state, that on one occasion Abdu Rehim rode his camel from the vicinity of our Camp No. VI to the Bos-ilek (Kontsche-darja), which he struck at a point about half-a-day's journey below Tikenlik. He estimated the distance between the Kuruk-darja and the Bos-ilek to be about the same as the distance between our camps No. VI and No. VII, or (say) 30 km. That is to say, it is only a moderate day's journey, considerably shorter than the distance between Jing-pen and Turfan-karaul, i. e. assuming Kosloff is right, of which, as I have said above, I am doubtful. The angle between the two rivers in this part of their courses is not at all great; in fact, they appear to flow almost parallel. The real divergence between them begins at the Avullu-köl. The country my guide rode over, when he travelled from the one river to the other, consisted at first of clay desert with jardangs, then of sand, the dunes of which, without ever attaining any very appreciable height, gradually rose as he approached the bank of the Bos-ilek; and this is in agreement with my own observations made on the eastern bank of the Ilek in 1896.

On the 15th March there was a fresh wind from the north-east, and the temperature did not rise above 6°.8 C. We were now compelled for some time to quit the Kuruk-darja, in order to water our camels at Jardang-bulak, and accordingly we climbed up on to the detritus slope by means of a little ravine. Here the clay dipped 15° towards N. 65° W., and rested upon the hard rock, a species of black stone resembling diorite, and with different inclinations, first at 26° towards S. 30° W., but having a steeper pitch the higher we proceeded up the ravine, namely 45°, 57°, 75° towards S. 30° W. When we got up on the open, the lie of the stratum was 26° E., and then 47° towards N. 70° E. In the next ravine, where we were again travelling towards the north-east, the dip was at first 27° S., then 78° towards N. 30° E. This ravine took us up to the flat summit of a little mountain-spur. On the other side of it we once more descended by a broad shallow valley running towards the north-north-east, and bordered on the west by low hills of a vivid red colour. Then to the north-east there opened out a very extensive area, a flat, shallow, cauldron-shaped valley, which to all appearance was perfectly level. Except for one portion in the north-west, lying just south of the road to Jigde-bulak and Toghrak-bulak, the mountain spurs are quite small. In fact, to the north, strange as it may appear, we scarce saw any mountains at all; whilst to the east there was nothing of that nature, except the flat spur we had just crossed over.

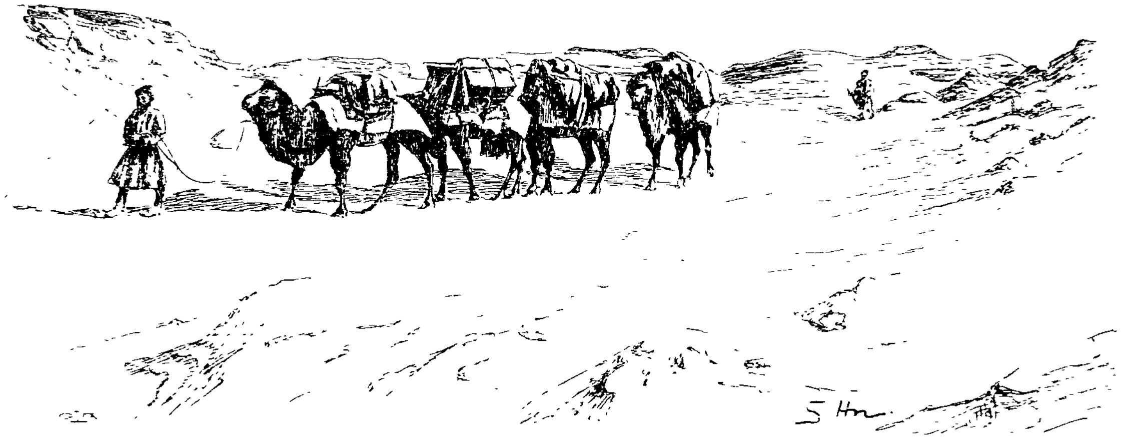

Fig. 48. A BROAD GULLY BETWEEN THE JARDANGS.

In the cauldron-shaped valley, or comb, just mentioned there is an oasis known as Oj-köbrük; it possesses however no water, though it does possess kamisch, tamarisks, and köbrük, or köuruk, a kind of tamarisk, kept alive by chance showers of rain. Here traces of wild camel were extraordinarily plentiful. The track leading to Jardang-bulak still continued to run north-east, crossing the comb diagonally; this last is shut in on the north-east by a low spur of the mountains. On the left we had a continuation of the narrow belt of meagre vegetation. The ground was schor, saliferous material, often glistening white, hard and granular, crunching under the feet — in fact, the same objectionable and tiring conformation as in eastern

Tsajdam. In some places however there were patches of level silt left by the rain.

On the farther side of the cauldron-shaped valley we climbed slowly up the next ridge, which consisted of a green coarsely crystalline variety of rock, greatly disintegrated. On the top we rode for a long way towards the east-north-east across a plateau, which undulated so gently that its slope only became evident when I lagged a good distance behind, and saw the caravan dipping down out of sight, as it occasionally did. Towards the north there were a couple of jardangs; but the mountains were very low and a long way off. From the lowlands of the Kuruk-darja we were separated by the low swelling of the foot-hills. The soil, thickly strewn with fine gravel, was almost completely sterile. The only living specimens of plant-life were a few tamarisks in an eroded gully.

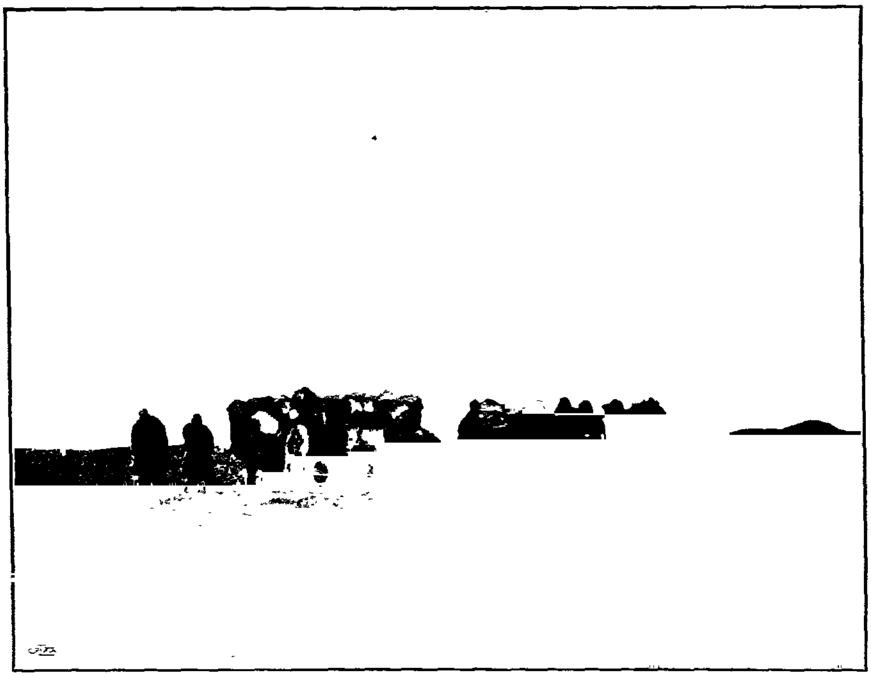

Fig. 49. ON THE SOUTHERN SLOPE OF THE EASTERN KURUK-TAGH.

But upon reaching the hollow in which the Jardang-bulak is situated we found a decided change; for this is a real oasis, having springs, thick luxuriant kamisch, and tamarisks. Here within a fairly limited area there are four distinct springs; (1) the one beside which we encamped, the Atschik-jardang-bulak; (2) half a potaj to the north-east the spring of Jokarki-jardang-bulak, which is stated to yield water, but has no grazing; (3) half a potaj to the south-east Tömänki-jardang-bulak, which possesses good grazing, but as a rule no water; (4) Jaka-jardang-bulak, a little farther towards the east-south-east, which supplies grazing and indifferent water. Thus the best of these miniature oases is Atschik-jardang-bulak; for it possesses an abundance of both grazing and fuel, while the water trickles out of several small springs in the bottom of the gully which has carved its way through the thresholds of solid granite. The water is, it is true, saliferous: the aerometer recorded a specific gravity of 1.012. But below the springs there were cakes of ice some decimeters thick, which, although fouled on the surface by wild camels and antelopes, nevertheless, when cleansed and thawed, afforded excellent water to drink. Thence it was said to be two and a half days' journey to Singer, over tolerably level ground, with small hills of no great consequence, and a comfortable pass in the neighbourhood of Singer. The district round Jardang-bulak is said to be called by the Mongols Schare-chalesun, or the Yellow Kamisch.

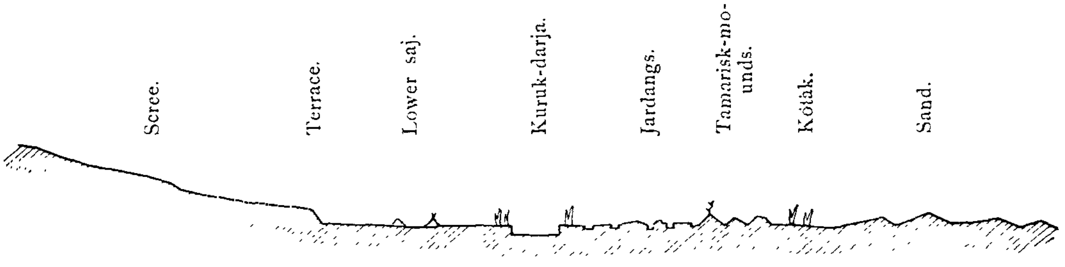

Fig. 50. VERTICAL SECTION NOT FAR FROM JAKA-JARDANG-BULAK.

On 18th March we directed our steps towards the Jaka-jardang-bulak, across gently undulating ground, with small rounded gravel resting on loose material; but the latter (lower) part of the journey the ground grew dusty and powdery. On the left was, quite close to our route, a spur about 100 m. high, in which the dark schist crops out in two or three places, otherwise the detritus gravel predominated throughout. The flank of this spur is seamed by a multitude of small gullies and ravines all opening out towards the south; the *jars*, or erosion terraces, which border them consist of the same clay as heretofore. Amongst the gravel there are not seldom pieces of dark violet porphyry. The farther we advanced down the gently inclined slope, the more numerous grew the step-like shelves and terraces pointing towards the desert. There are also numerous detached clay blocks, resembling the ruins of houses and walls. It is in vain one looks for a trace of human beings; there is not so much as a footpath. We saw however a ravine, or «corridor», with sides some 10 m. deep, and higher up bordered, as it seemed, by a dark rock, severely weathered. This ravine, known as Kara-aghis, is reported to possess in its upper part a salt spring surrounded by grazing. Finally, after passing yet another series of shelves and terraces, we descended to the level ground by a second ravine, in which we found the salt-spring of Jaka-jardang-bulak. The rivulet which flows from it gives out however just below the spring. It must therefore be rain-water that finds its way through the ravine, and affords nourishment to a small patch of exceedingly vigorous kamisch just beyond the end of the ravine. On the north this field of kamisch is fenced in by the fantastic, greyish-yellow walls and blocks of the clay terrace. To the south the desert is level, and there is no high sand visible. The ground is everywhere richly impregnated with salt, in some places actual lumps of it lying embedded in the ground.

On the 19th March we travelled towards the east-south-east and the south-east. The kamisch patch of Jaka-jardang-bulak soon came to an end. On our left we had constantly the upper terrace, sharply outlined like a wall or a series of rounded hills, very often pierced by erosion gullies, in the ends of which the light yellow clay was always exposed. Below the terrace extends a gently sloping belt of saj, which merges imperceptibly in the level clay desert. At a very short distance away the Kuruk-darja betrays its course by its *jar* terraces, its tamarisk-mounds, and the kötäk on its banks. After the termination of the greater part of the gullies which issue from the confines of the mountains there is a gravel-and-silt slope, down which the rain-water rivulets, radiating outwards like deltas, are clearly indicated. For a short distance we kept to the edge of the upper saj. The clay was distinctly stratified, the beds being sometimes horizontal, sometimes with a gentle inclination, the dip being in one place 20° E. Descending by a narrow, barren transverse gully, we once more came out upon the clay desert, which I proposed to cross south-eastwards until we struck the belt of sand. In this locality there exist immense quantities of *Limnæa* shells, some amongst the low sand, others amongst the loose clay. In places they lie so thickly that they could be gathered up by thousands; and they accompanied us throughout the rest of the day's march. Seeing that they are in this way distributed pretty evenly over a tolerably wide area, it is fair to suppose that we were travelling across the bed of a former lake, or a chain of lakes and marshes, linked together by a river, or else one or several marginal lakes which extended by the side of the old river. Otherwise the mollusc-shells would have been arranged in rows. It is likely too that the wind may to some extent have assisted to scatter them over the surface, for they are light and

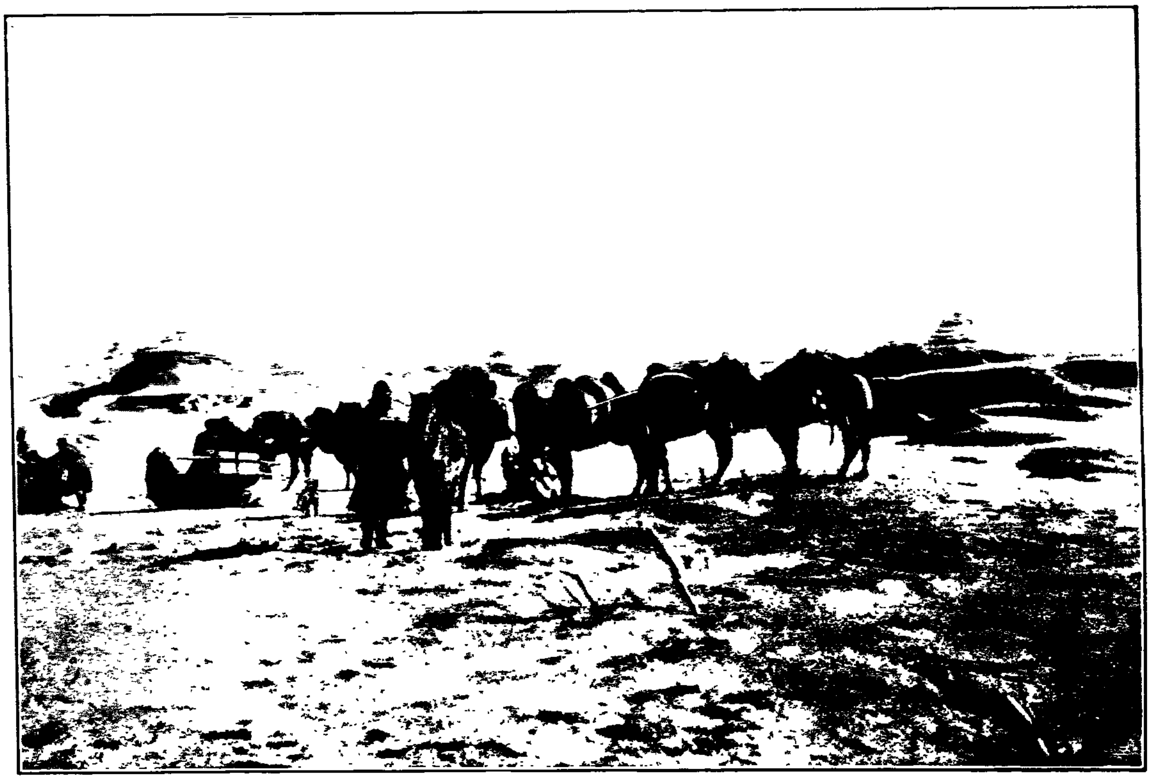
Fig. 51. CAMPING BETWEEN THE JARDANGS.

thin, and if they lay in suitable positions, it would be able to lift them and transport them along the ground. Still it would be no very great distance they would travel in this way; for they occur precisely in the region where the Kuruk-darja flowed, and vast quantities of them still lie on the very spots where they originally settled.

Then for a space we had tamarisk-mounds, with living bushes on them; the ground near by being in two or three places moist. Here you could certainly soon dig down to water, though beyond doubt it would be saliferous. For a short distance the Kuruk-darja was here outlined with extraordinary distinctness. Its high, steep, sharp-cut erosion-terraces are crowned with tamarisks, tamarisk-mounds and kötäk, both standing and fallen. The dead forest clings like a skeleton to the lifeless banks, which nevertheless show so distinctly and so palpably that water once flowed between them. In the next bend the banks were 4 to 5 m. high, counting from the bottom of the river; the bed was in some places slightly moist, in other places thinly strewn with gravel. The features of the landscape were peculiar. On the whole the surface appeared to be level. The winding, cañon-like gully or ravine was no longer visible, and yet I could hear the tinkle of the camels' bells quite close at hand, as I rode amongst the kötäk on the bank. It was not until I stood on its very verge that I became aware of the winding trench which has cut its way through the clay desert. The colouring was a universal yellowish grey — the clay soil, the kötäk, and even the sky itself — a lifeless and monotonous region! Often enough it was difficult to make out which way the river went; it was as full of windings and sharp bends as the lower Tarim, and appeared likewise to split into a number of arms. Sometimes we climbed up out of one of these arms and travelled for a while on the top of the terrace, until after the lapse of a few minutes, we would again find ourselves on the edge of a fresh gully, resembling the one we had just climbed up out of, though lying at right angles to it. Then it sometimes took us a good hour's search, and entailed a long detour, before we succeeded in getting across the new obstacle, or descending its steep side.

# CHAPTER IV.

## ACROSS THE JARDANG DESERT TO ALTMISCH-BULAK.

We now turned our backs upon the Kuruk-darja, and continued towards the south-east, the going being exceedingly difficult in consequence of the numerous gullies, and *jardangs*, or ridges, 2 m. high. At intervals came gigantic mounds, standing either singly or in groups, and crowned by veritable plumes of kötäk or tamarisk. In suitable places the sand was heaped up, but without forming actual dunes, though dunes were visible one or two kilometers farther south. Two or three times we observed fresh tracks of hares and foxes; both these animals frequent the adjacent mountains. In proportion as we advanced away from the Kuruk-tagh, the jardang ridges grew lower and lower, until at last they were only about one foot high. All the same they made travelling very difficult and tiring, for we had to cross them all at right angles, and there were vast numbers of them and they were hard. We now picked up our first find, a fragment of a baked clay jar, as well as a piece of slate, $1^{1}/_{2}$ dm. long and 1 dm. broad, which had evidently been used as an axe. These were the first ancient traces of human beings we discovered beside the Kuruk-darja.

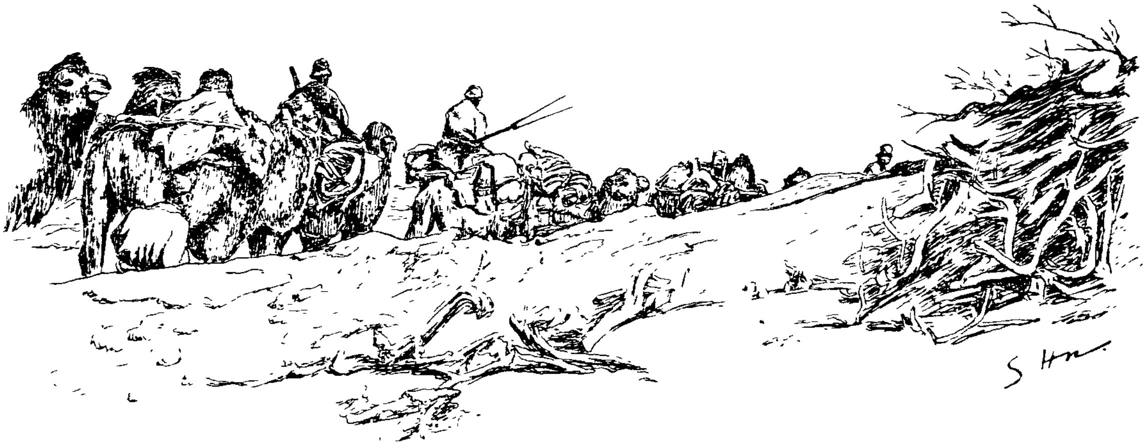

Fig. 52. OLD TAMARISKS ON THE BANK OF THE KURUK-DARJA.

As far as we were now able to see, dead forest was very general, especially toghrak, tamarisk, and jigde. The poplar trunks, which were well embedded in the sand, and so protected by it, were considerably bigger than those which still stood upright; the latter were all slender, though in a decided minority as regards numbers. During the lapse of ages, in their long struggles against the storms, most of these trees have been overthrown, nor will it be long before the last of them falls. It may however be taken for granted, that, even after the stream ceased to flow down the Kuruk-darja, and it was finally condemned to dry up, its forests did not die out all at once, or simultaneously, throughout the whole of its course; but they would die piece by piece. Trees which grew in relative depressions and those whose roots penetrated deeper would naturally survive the longest. Probably some groups of toghraks may have preserved their vitality to a relatively late period. Quite unexpectedly we came this day upon a clump of 14 living poplars of medium size, the only ones we met with in all this ocean of desert. They were, it is true, at the last gasp, on the very verge of extinction; but there was still a faint trace of sap in their interior, for a branch here and there had put forth leaves, or rather leafbuds. The roots of these trees must of course have reached down to the groundwater, but their ability to do so was plainly at an end, and within a short space they would be overtaken by the fate of their neighbours. They stood no doubt in a slight depression, though we were unable to perceive that it was such. Thus the poplars which remain standing beside the Kuruk-darja are clearly trees that were long able to derive nutriment from the moisture of the ground, and died at a relatively late period.

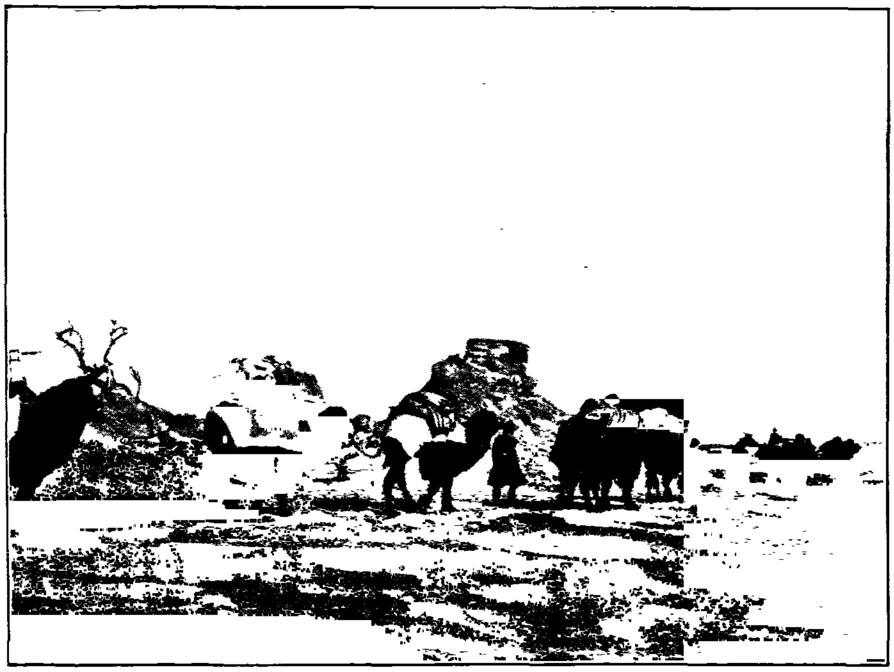

Fig. 53. A JARDANG AND A PIECE OF DEAD TAMARISK IN THE DESERT NORTH OF KURUK-DARJA.

In this region too there is an abundance of dead kamisch; and ancient steppe covers extensive areas. The former was only one decimeter high, and was so interpenetrated with sand, and so dry and brittle, that it crumbled at a touch like rotten wood, and refused to bend at all. These fields of kamisch grew on the banks of the former river, and beside its marginal lakes, just as we find them growing to-day beside the Tarim and its marginal lakes.

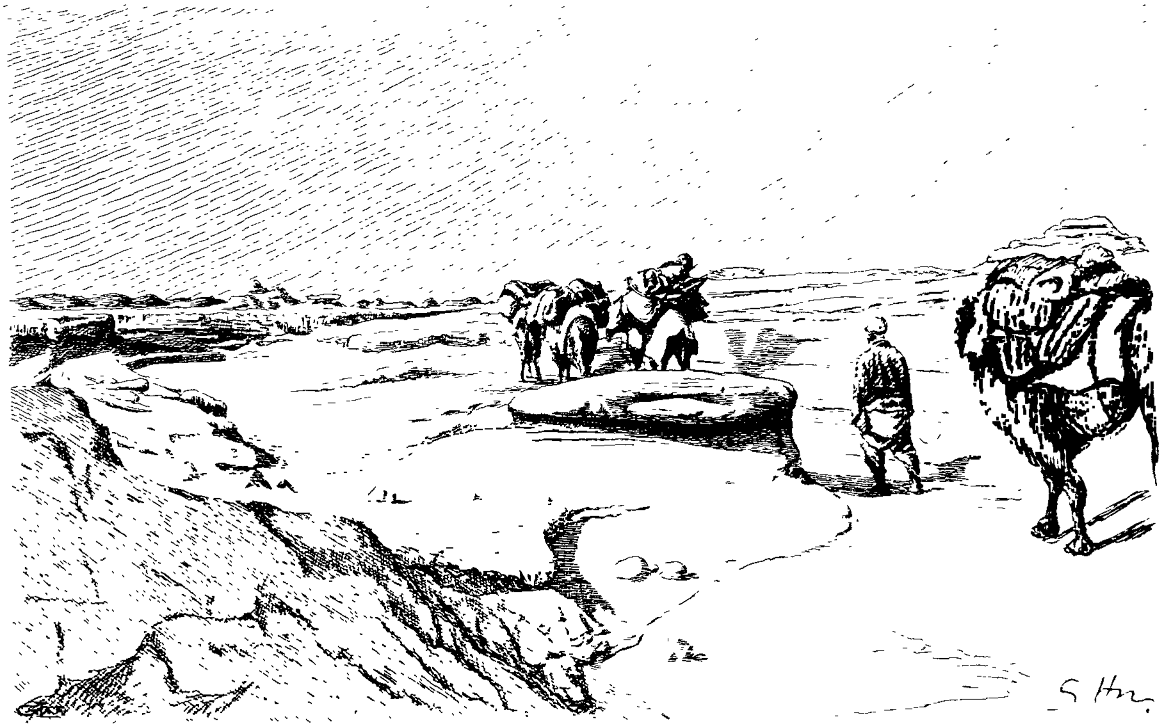

Fig. 54. IN THE KURUK-DARJA.

On the other side of the belt of kamisch the drift-sand gradually increased in quantity, forming crescentic, regularly shaped dunes, 3 m. in height, but standing isolated, with their steep faces turned consistently towards the west-south-west. As we advanced, the dunes increased in height, until we reached a point only a little way short of the continuous dunes of drift-sand, and as we had thus got to the outside of the region watered by the former Kuruk-darja, we turned and went back to the dry bed of this river. Camp No. X was formed not far from the edge of the sandy desert. Although there was kötäk amongst its dunes, there was no living vegetation, nor were there any tamarisk-mounds.

At the points where we crossed over the old river-bed during the course of the day's march it presented, apart from a few variations in detail, the following vertical section: a distinctly marked water-channel, with kötäk on its banks, and at intervals detached clay-terraces and table-topped heights in the bed. Its dimensions were: breadth 75 m. and depth 5 to 6 m., and although these measurements varied constantly, it was within narrow limits.

From Camp No. X we directed our steps, on the 20th March, towards the north-north-east, across a desert furrowed by the wind. Its more exposed parts, the jardangs, were as hard as asphalt, and though the gullies in between them were full of soft material, it too rested upon hard clay. It is of course inevitable, that those portions of the desert which are accessible to the wind should be swept clean and become hard, as also that the fine drift which drops into the gullies, being relatively sheltered from it, should remain where it falls. In a few places we noticed a thin layer of brown, rather coarse-grained sand, which likewise rested upon the clay. In this direction again kötäk was very plentiful, both standing and lying on the ground. Once there were primitive forests here, of the same kind and appearance as any of the finest forests standing to-day beside the Tarim. In one locality the dead, withered, stumpy tamarisks stood so close together, and were so big, that we had to exercise the utmost caution in threading our way through them; this had once been an impenetrable tamarisk thicket. A few kilometers east of Camp No. X we perceived a solitary toghrak still retaining a spark of vitality; it was evidently in the same depression as the clump I have spoken of above. But on the whole the desert grew more desolate, and the vegetation nearer the verge of extinction, in proportion as we advanced towards the east.

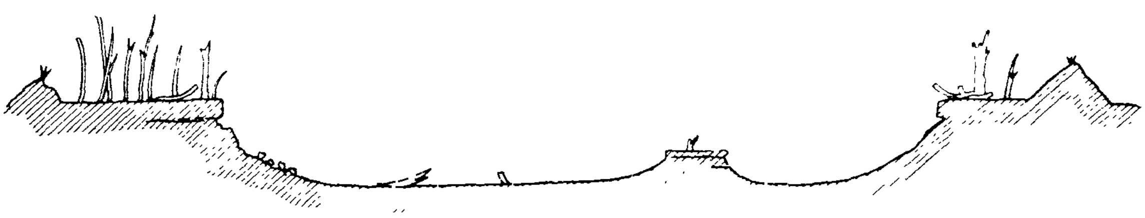

Fig. 55. VERTICAL SECTION OF THE KURUK-DARJA.

At length we once more reached the Kuruk-darja, striking it at a couple of bends, in which its bed was marked with exceptional distinctness and was unusually well preserved. At the point where we touched it, the river-bed was 94½ m. broad, and its containing banks 6½ m. high. These last were still provided with an abundance of dead forest; on the lower side, next the saj, it kept close to the edge of the terrace. During the rest of the day we followed this same terrace towards the east-north-east, having on our immediate left the flat slope of the detritus scree, backed on the north by a small mountain chain, abundantly grooved, which terminated upwards in a level crest or ridge, with no outstanding summits. And, with a few insignificant exceptions, the slopes of the Kuruk-tagh maintained the same aspect during several successive days to the east. They incline towards the desert, which is perfectly level, at a slow rate and low angle. Owing to the refraction of the atmosphere, the most distant parts appeared to hover a little above the surface of the saj. This is generally narrow, in some places only a few hundred meters broad, and its inclination does not at most exceed a few degrees. Its surface is thinly strewn with fine dark-coloured gravel, principally flint, with soft material underneath it, into which the small stones sank when the camels trod upon them; hence their footprints were distinctly visible, being of a lighter colour. But it apparently needs only a little wind, one day's good blow, or two, for these same stones to become exposed again; of this we had evidence in the footprints of the wild camels. The old tracks were just as dark as the ground itself, and the little depressions were filled with gravel, lying loose in them, whereas the fresh tracks were lighter, owing to the disappearance of the stones into the soft material underneath, and it is only when this last is blown away that they come to light again.

Fig. 56. EFFECTS OF REFRACTION.

The lower saj is furrowed by innumerable watercourses of all sizes, with hard clay bottoms. At one spot, where the Kuruk-darja hugs the base of the lower saj, we observed the termination of a pretty big gully coming out of the Kuruk-tagh. To the north of this, behind the nearest shoulder of the mountains, there is said to be a spring called Muchlaj-bulaghi, or Muchlaj's Spring, after the Mongol who, some forty years ago, is reputed to have discovered it. West of the same lies the spring of Kak-su, and the low-lying mountainous parts around this are known as Kök-tagh. At the close of the day's march the two saj terraces appeared to melt together without there being any step-like transition between them. Most of the fresh-water rivulets which come down towards the Kuruk-darja, and no doubt once discharged into it, now turn aside towards the east; that is they are deflected towards the south-east. The Kuruk-darja was frequently visible from the saj, owing to its distinctly marked terraces showing at the bends, as well as owing to its dead forest. But in certain places its bed disappeared; no doubt this was where it formerly traversed shallow lakes.

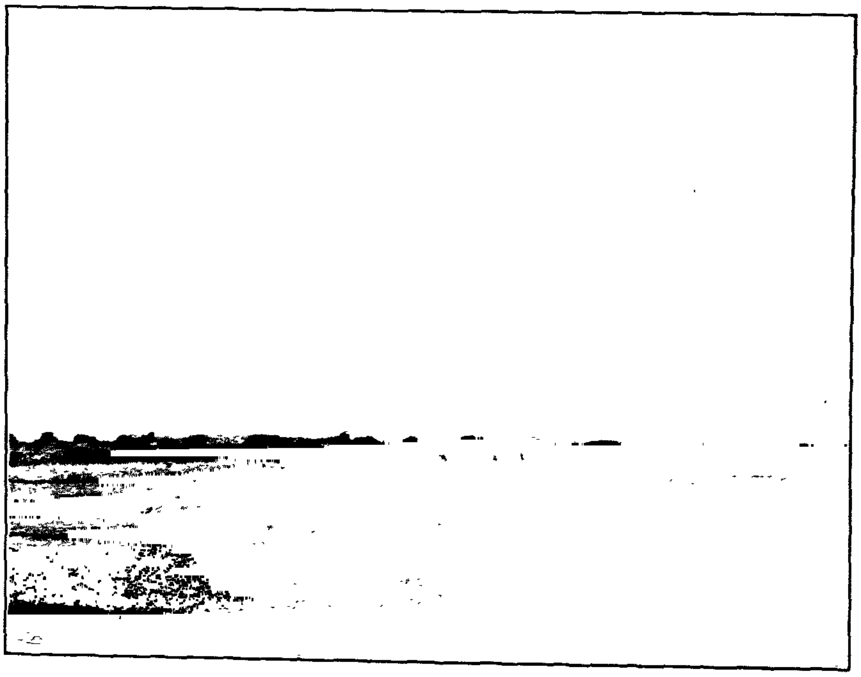

Fig. 57. ON THE NORTHERN BANK OF THE KURUK-DARJA.

At Camp No. XI there were a number of living tamarisks in the bed of the Kuruk-darja, this being there exceptionally wide as well as moist. The following springs were named to me as being situated in the mountains to the north — Noghusun-tu, or the Duck Spring; Teschik-bulak, or the Hollow Spring, the water collecting in a hollow or hole underneath a tamarisk thicket; Olun-temen-tu, or the Spring of Many Camels, showing that wild camels are numerous there; and Buru-tu, or the He-Camel's Spring. Thus all, with the exception of Teschik-bulak, bear Mongol names. They lie in fact along the boundary-line between the two languages; and in the geographical nomenclature also Turkish names are gradually replaced by Mongolian.

Upon starting on 21st March we followed, eastwards, a much-trodden camel-track; but it was manifestly made by a single troop, for it is contrary to the wild camel's nature to keep to beaten and well-recognised paths in the desert. The lower saj was now at the same level as the desert, and consequently exhibited no well-marked edge. On the other hand the upper saj on our left still continued to be quite distinct. The ground consisted sometimes of soft material strewn with gravel, sometimes of *kak*, or level expanses of silt deposited by standing rain-water. The latter had cracked into polygonal concave cakes, rather thin and brittle, and had mould or sand underneath them. The upper and bigger terrace step now receded towards the north, and soon disappeared from sight, its place being taken by a smaller shelf, only two or three meters high, which approached quite close to us on the left. But after a while this also came to an end, and was succeeded by a gently undulating surface, which extended all the way to the foot of the nearest mountains. These however, although possessing a distinctly outlined, somewhat jagged crest, were in point of altitude more like a chain of hills. The soil was now absolutely sterile, the scenery terribly dead and desolate. We did not see a single living creature all day, although the tracks of the wild camels became more numerous as we advanced towards the east. Southwards stretched the clay desert as far as we could see, etched, as it were, with innumerable gullies running in the direction of the wind; but there were no dunes. Kötäk was rare, and we very seldom saw a tree-trunk standing; tamarisk-mounds were equally rare, and they were without kötäk. The well-marked trench known as the Kuruk-darja, which we had hitherto faithfully followed, now came definitively to an end. East of Camp No. XI there was not a trace of any old river-bed; nor was there any marginal forest to indicate a former river-course. The only break in the surface of the clay desert was caused by the smaller gullies. The Kuruk-darja came to an end, as I have just said, at Camp No. XI; as so often happens in the case of a river that discharges into a lake, it expanded and spread out at its termination. South and east of us stretched the bottom of a former lake, to wit Lop-nor, the old Lop-nor of the Chinese, into which the Tarim formerly discharged. Later on, when we came to cross the Desert of Lop from Altmisch-bulak, we failed to discover any continuation of the Kuruk-darja; so that I may with reason claim that I followed the whole of its course from Jing-pen to its ancient mouth, with the exception of a short stretch south of Oj-köbrük and Atschik-jardang-bulak. The point to the south of Altmisch-bulak from which Kosloff thought he could see the Kuruk-darja (Kum-darja) lies east of the point where the river-bed actually comes to an end. What he did see was therefore a portion of the lake-basin. What led him to interpret this desert as just the place for a darja was no doubt the information which he received from Abdu Rehim.

To travel from the region in which we then were first up to Altmisch-bulak and then back again across the desert would mean a serious loss of time, for it was a long way round; I hoped therefore that I should be able to proceed from the vicinity of this dried up lake-region direct to the Kara-koschun. But before we could venture to do that, it was imperative to augment our water-supply by digging a well. With the view of finding a likely place for this object, we directed our steps south-east across the jardangs. Before we got very far from the edge of the saj we came upon a dozen hard-baked earthenware cups and dishes, which my Mussulmans pronounced to be of Chinese manufacture. Two or three of these vessels were of very considerable size. On the border of one dish there was a simple ornament, consisting of an engraved wavy line. A small cup, one-half of which was unbroken, had the form shown in the annexed cut (fig. 58). At length we came also upon an edging of copper, with a horizontal flange, which in all probability had belonged to a large cooking-pot or sauce-pan, like those the Mongols boil their tea in. These discoveries are of great interest, for they prove that this region was once inhabited, and no doubt mark the site of a homestead or small village on the north shore of the former lake. It is not credible, that these fragments of pottery can have strayed here in any other way; for instance, it is not likely that they were flung away by travellers journeying from Jing-pen to Lôu-lan on the northern shore of Lop-nor. It is more reasonable to suppose that there were homesteads and stations along this road, at longer or shorter distances apart. But despite all our eager search from the tops of the highest jardangs and tamarisk-mounds, we failed to detect the smallest trace of either houses or timber that had been worked by human hands. If ever there were such here, they have been destroyed by the tempests.

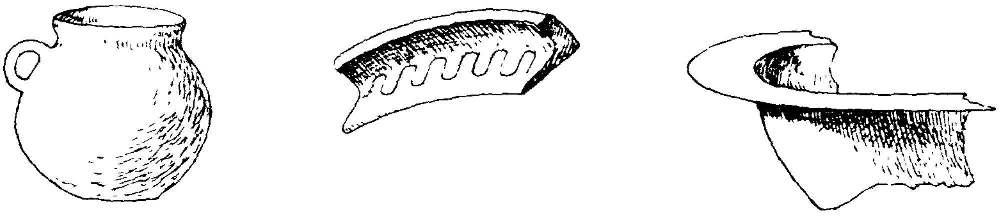

Fig. 58. VESSELS FOUND ON THE BANKS OF THE KURUK-DARJA.

In two or three places we perceived tamarisks with a spark of life still left in them; but it was easy to see that this was not the region in which to dig a well. Kötäk occurred here and there, and was only at all thick in a single spot, where it formed a continuous belt; several coarse tree-trunks lay prostrate on the ground. These must have been of an immense age, for they were as brittle as glass and of a light grey colour. Once however they must have formed quite a dense forest, although of limited extent. It is plain that this strip of forest formerly stood on the shore of the ancient lake. But all at once, about a couple of hundred meters away, the kötäk came to an end, and there were no trees to be seen except a solitary shrivelled tamarisk or two. It is therefore not rash to suppose, that at these poplars we quitted the lake-side, and that the sterile ground belonged to the bottom of the former lake. Here again the surface was plentifully littered with *Limnæa* shells, some whole, others fragmentary, generally lying loose upon the soil, though sometimes they were fixed fast in the clay faces of the jardangs, whence they are chiselled out by the wind. The ground consisted here of the same fine yellow clay as before. Its several layers, of varying degrees of hardness, were extraordinarily distinct, and had in general a dip of 2° to 3° to the SW. and W. Sometimes however they dipped as much as 20° towards every point of the compass. In other words, they bulged upwards, the bulging having taken place whilst the clay was still wet, so that there was no break in it. The mollusc-shells embedded in it prove that it was originally deposited in the basin of a fresh-water lake. The slight fall may be more apparent, the sediment having been deposited more abundantly in some parts than in others, for instance around the embouchure of the river. Each successive high-water period has added a fresh layer of silt; each successive storm has added a thin layer of sand.

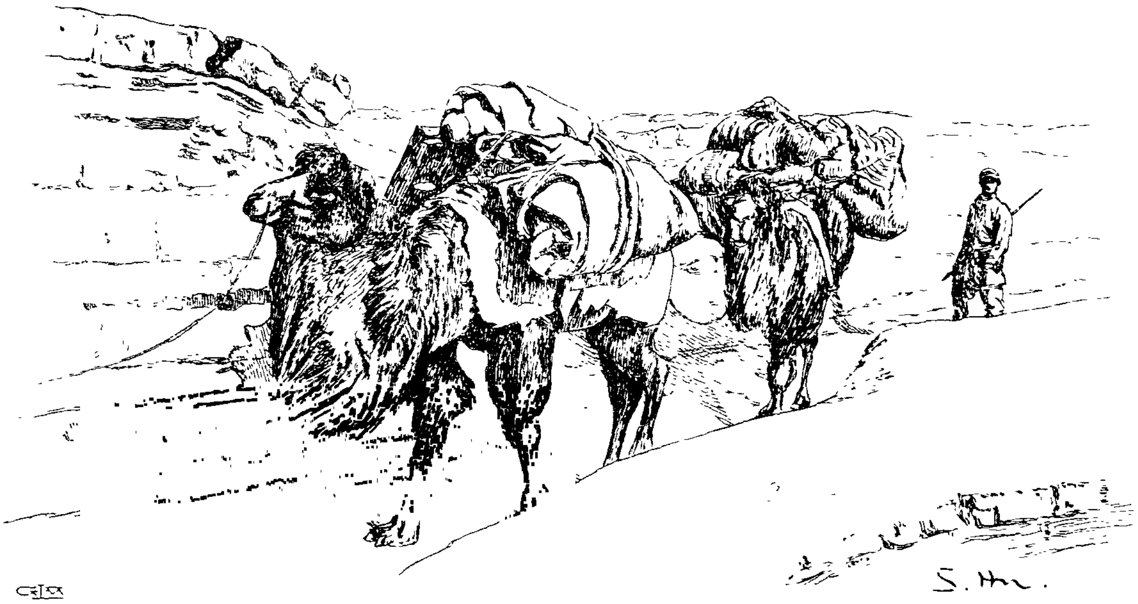

Fig. 60. IN A GULLY BETWEEN TWO JARDANGS.

With amazing regularity and without the slightest interruption, this dry clay soil is furrowed throughout by pretty deep gullies, which separate the jardangs one from another. The only variety they present arises out of the consistency of the surface, that is to say, out of the varying resistance which it has offered to the corrosive, abrading force of the wind. Over a considerable area the jardangs lay as depicted in the accompanying schematic sketch (fig. 60). Each ridge was broken off pretty abruptly on the north-east, but had a gentle slope towards the south-west. But an even commoner conformation is that shown in fig. 61, which represents a vertical section from north-west to south-east across a number of jardangs. These ridges are often hundreds of meters long, and run uniformly from north-east to south-west, and are everywhere pretty much the same relative height above the gullies on each side of them, namely from 2 to 3 meters. To cross a country like this at right angles to the ridges is indeed possible to a man — on foot; but for camels it is both tiring to the animals and trying to the patience of those who travel with them. The only way to advance is to zigzag backwards and forwards through the gaps in the jardangs. After proceeding in this way for some distance, and finding that the character of the country did not alter, and having convinced ourselves that it would be idle to attempt to dig a well, for there was not the smallest sign of a living tamarisk to be seen, we at length turned back towards the north-east. That of course greatly eased our march: we were able to keep to one single gully, and travelled as it were in a passage-way, our view being greatly impeded by the high jardang walls on both sides of us, so that we were obliged to scramble up them time after time to obtain some idea of what the adjacent country was like. Lower down we shall make a more general acquaintance with the Desert of Lop, and I will then compare these jardangs with the other phenomena in the relief of the desert. For the present, I will merely observe, that they are the result of the activity of the prevailing wind. Many instances occur of its having scooped out in the side of a jardang a cup-shaped but elongated hollow, beautifully rounded, forming a sort of grotto with an overhanging cornice. In the end the cornice, which is plainly composed of harder and more compact clay than the material which has been scooped out from underneath it, breaks off, so that it is no uncommon sight to see blocks, lumps, and fragments of hard clay littering the bottom of a gully.

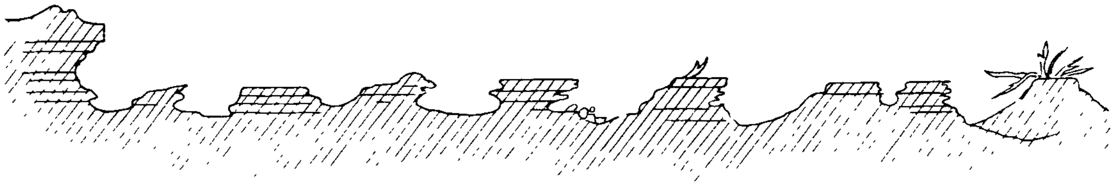

Fig. 61. VERTICAL SECTION OF JARDANGS.

At the spot where we turned north-east, with the intention of going after all to Altimisch-bulak, there was scarce any kötäk whatever to be seen, except very occasionally a dead tamarisk. Even tamarisk-mounds were very rare, as indeed might be expected in the basin of a former lake. Dunes were equally absent. We failed to discover even the rudiments of one; although at the same time quite low ribs of sand, or a thin layer of the same, had accumulated in a few places suitably exposed to the wind. But they were too small to be called even rudimentary dunes. The northern part of the Lop-nor is therefore free from sand. In other words, there is no accumulation of drift-sand in the region immediately below the detritus slope of the Kuruk-tagh, the region through which the Kuruk-darja formerly flowed, and in which it formed the lake of Lop-nor. Had the water disappeared from this region at no very distant epoch of time, there would be reason to suppose that it was the water itself, and the rich and abundant vegetation — toghrak forest, tamarisk steppe, and kamisch-fields — which usually accompany the water, that had prevented the sand from forming dunes. But in point of actual fact, it is so long since the water disappeared, and the desert has so long reigned supreme, that in respect of time there exists no reason why drift-sand should not have accumulated, at all events into small dunes. No, the reason why dunes are wanting is, as I have hinted, something different, namely the prevailing wind, its force, and regularity of direction, as well as the peculiar relief which it has itself given rise to. The drift-sand, which has its origin in the greatly disintegrated ruins of the adjacent Kuruk-tagh, is swept south-westwards by the tempests of unexampled violence which blow here, and which, after they leave the detritus slope, career unchecked across the northern part of the Desert of Lop. In this way the wind becomes a powerful agent of erosion in its hands, by means of which it scoops out and planes down the innumerable gullies between the jardang ridges. The tops of these ridges would correspond to the original level of the clay desert, were it not that they too are worn down by the wind and its instrument, the sand it drives before it. Nevertheless the parts which have been most severely attacked are the gullies. Seeing now that, from the very nature of the case, these trenches all lie parallel to the direction in which the wind so constantly blows, it is perfectly obvious that it is a sheer impossibility for the drift-sand to secure a footing and establish itself amongst them. Any sand that does by chance remain in them at the tail-end of a subsiding storm is instantly swept away by the next tempest that sweeps across the desert. Each of these gullies may be compared to a rifle-barrel, through which the sand and finer particles of the crumbling jardangs are shot like projectiles, the wind acting as the explosive force that drives them forward. The exceedingly small and very rare layer of sand to which I have alluded a page or two back, as lying in some of the gullies, may in part have been left by the dying gasps of the last storm that swept across the desert, and would probably be blown away by the next storm that followed. It is more likely however that it lies in tiny angles of the gullies or in parts which are relatively screened against the wind. It is possible that, if the clay desert were perfectly horizontal, sand-dunes would have been formed here in the same way as in the south-west parts of the same desert, where the storms occur with the same constant regularity. But as the relief now is, the gullies act like river-beds, as conduits for the sand, so that it has not sufficient room to build up a dune of the typical crescentic or scutiform shape. And yet this too can hardly be credited, for after the country was converted into a barren desert, its clay surface must, in the immediately succeeding years, have been as level and as even as any other region in that part of Asia. If sand-dunes were formed *at that time*, they must either have been swept away or they must have maintained their position, in which case they would naturally have proved a hindrance to the wind's erosive activity, and the gullies and jardangs would never have come into existence. Hence their presence is a proof that the northern part of the Desert of Lop has never been sanded over. I assume therefore three different causes for the absence of the dunes in the northern part of this desert.

(1). The regularity and inconceivable violence of the north-east wind, combined with the long continuance of each individual storm. It is clear that, even if other winds, e. g. the south-west, prevailed, the masses of sand would be shifted now in one direction, now in the other, the result being, that it would remain on the whole tolerably stationary, as does happen in several sandy deserts, for instance, at all events to a partial extent, in the Desert of Kara-kum in Transcaspia. In the Desert of Lop however the wind, at least the wind that is powerful enough to move the sand, always blows from the north-east. Every tempest that arises signifies therefore an advance or shifting forward of the sand in one and the same direction, a fresh step towards one and the same goal. Once the sand has passed a given point, it will never return to that same point again, and all the sand which happens to be in this part of the desert at a given moment is simply, as it were, a »through traveller»: it flows on in a steady stream, constantly towards the south-west.

(2). The relief of the desert. The presence of the gullies renders the origini-nation of dunes impossible, though this is only true when taken in conjunction with the direction of the prevailing wind, which blows parallel to them. Were this less powerful, it would perhaps permit of the formation of minor dunes in the gullies, and these might in the course of time grow above the tops of the jardangs. But under existing conditions each successive storm sweeps all these gullies pitilessly clean of every particle of loose material.

(3). For the formation of dunes at a given point it is an indispensable condition that there should exist some sort of obstacle, and with natural obstacles of this kind the Desert of Lop appears to be especially ill provided. On the contrary, owing to the disposition of the wind-eroded gullies, it is peculiarly favourable for the unhampered movement of the sand in the same direction as the wind. By obstacles I mean here even such minute irregularities of surface as a few grains of sand or a »ribbing» of sand only one mm. high, for even such diminutive elevations as these have no chance to form in this part of the desert.

The jardangs we passed on 21st March were, as I have said, not more than 2 to 3 m. high; this is therefore a measure of the depth to which the wind-erosion has scooped out the desert. The reason it has not dug down deeper is that it has only been at work since the Kuruk-darja and the Lop-nor disappeared from the region. But the relative difference in elevation between the bottom of a gully and the top or platform of a jardang does not give the index of the full activity of the wind. This is no doubt most powerfully expressed in the gullies, through which the wind penetrates, so to speak, in a compressed form, thereby having its sculpturing force intensified; but it also takes effect upon the summit of the clay ridges, filing and planing them down. In respect of relative height these surfaces cannot exceed a certain maximum, which would appear to be proportional to the breadth and other dimensions of the gullies and jardangs. The greater and broader these wind ravines, the higher and broader also the jardangs between them. In the following pages we shall encounter several varieties of them, varying from a breadth of one foot to 10 m. or more. It would be difficult to discover the laws which determine the different dimensions of the gullies in different localities. I dare say the varying consistency of the soil, i. e. the varying percentage of intermingled sand, has something to do with it; and the amount of sand that is intermingled with the clay does, as an actual fact, vary in different quarters. The clay was deposited in a lake, but has been mixed with larger quantities of sand in the northern part of the desert than in the southern. And then there are of course gullies in a transitional state, so that a region which is now furrowed by small and narrow grooves may in the future exhibit broader and bigger ones — gullies — after several of the smaller ones have, through continued erosion, become joined together.

Generally speaking, these gullies lie at an acute angle to the line of the Kuruk-darja. But as the river meanders along a serpentine course, those parts of its bed which have lain open to the wind have undoubtedly been still further widened by its agency. Considering the incessant filing to which it has been subjected by the drift-sand, it might be expected that the river-bed would ere this have been totally obliterated. I have said that we saw the last portion of it at Camp No. XI, and consequently I have assumed that that was the point of its embouchure into the former lake. Still it is quite conceivable that it may have continued yet farther towards the east, but that its farther eastward extension has been blotted out. As a general rule, it may be said that the Kuruk-darja grows less distinct as it proceeds towards the east, and for two different reasons. Its transformation into desert has advanced from its lower part to its upper part. When the water ceased to flow, it was of course the parts around the river-mouth which were the first to suffer, whilst the higher parts of its course were still reached by the dwindling current, so that there the transformation into desert was delayed. Thus the more easterly portions of the river-bed have been longer exposed to the levelling operations of the wind. The second cause is the decrease in altitude of the Kuruk-tagh from west to east, so that the north-east and east-north-east winds have freer play towards the east, and consequently they sweep more unchecked over those parts of the desert than over its western parts, which are relatively better protected by the mountains and the detritus slope with its terraced foot.

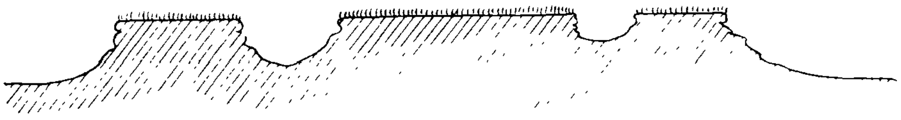

Fig. 62. KAMISCH STUBBLE IN THE DESERT.

All the same, the river cannot have proceeded very much farther than the point which I regard as its termination beside Camp No. XI. This is also proved by the change in the surface conditions beyond that point, the thinning out of the dead forest, and in places its entire cessation, the abundance of mollusc shells, the presence of kamisch-fields. With regard to the last-named, their existence would appear to militate against my contention, that the wind planes away the clay surface layer by layer. But no; the position of the kamisch-fields constitutes on the contrary one of the most convincing proofs of the deportation of material. For, as may be seen from the accompanying illustration (fig. 62), the stubble of the dead kamisch is always found on the platforms and elevated parts of the clay. Wherever it has grown, and bound the soil together with its roots, or still does so, even though its roots are now withered, the wind is unable to carve out gullies, and the soil remains at its original level, or shows only an extremely small and imperceptible decrease. On the other hand, those parts which are free from reeds have been excavated all the deeper, and now form depressions encircling the kamisch-fields. We have already seen, that the deeper parts of the numerous kamisch-lakes which I have described, such as the Kara-koschun and Kara-köl, are free from reeds; indeed reeds seldom grow in greater depths of water than 2 m. The vertical section shown in fig. 63 is such as may generally be found in these lakes, with kamisch growing upon the sand-banks and elevated parts of the lake-bottoms. Imagine a basin of this character to become dry, and the wind to have free play across its surface, it is easy to see that the kamisch-grown ridges will be protected against its erosive energy, while the deeper parts of the basin between will be still farther deepened by it. This is what has happened with regard to the kamisch-fields in the Lop-nor, as well as in several other instances that we shall encounter lower down. These kamisch-fields grew either on the shores of the former lake or in the shallower parts of its basin, whereas the adjacent areas, which are free from kamisch-stubble, correspond to the deeper parts of the lake.

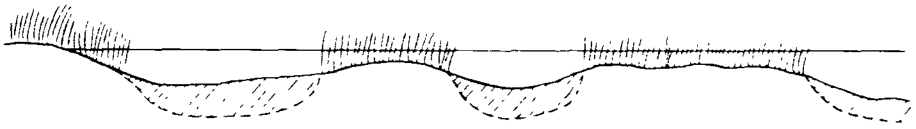

Fig. 63. KAMISCH IN A LAKE.

Here I may reasonably observe — although we shall later on have more convincing proofs of it — that the kötäk is always found on the tops of the jardangs, clay ridges, and elevated parts of the desert, never in the gullies and hollows, unless, and exceptionally, it has fallen into them in consequence of its having been undermined by the wind, or is, as in the Kuruk-darja (see fig. 55), really drift-wood of a very aged character that lies half buried in their bottom. Thus here again it is the ancient vegetation, and its roots, which have enhanced the power of resistance of the clay desert, and prescribed where the jardangs should be left. Had the poplar in fig. 64 stood upon perfectly level ground, and there died in consequence of the withdrawal of moisture, then the loose, dry layers, not bound together by vegetation, and situated at the side of it, would be gradually deported by the wind, until at length the poplar would be left upon a base of varying height. But then, owing to the constancy with which the wind blows from one direction, the leeward side of the base or pedestal just mentioned affords a certain amount of shelter to the ridge behind it, and this, being relatively undisturbed by the wind, eventually forms a jardang. Still this protection will not extend very far, and finally those parts of the jardang which are destitute of roots, will be destroyed. The result is something like the tamarisk-mound, except that this last is invariably characterised by its regular, rounded shape.

We pitched Camp No. XII in an absolutely sterile spot, in the vicinity of a depression about 50 m. broad, 2 m. deep, and a couple of hundred meters long, lying exactly parallel to the wind-eroded gullies. Had it not been bordered on both sides by dead toghrak forest, pretty thick, with the trees both standing and lying on the ground, it might have been taken for an unusual expansion of one of these gullies. Its form betrays however that it is an old river-bed, evidently a short connecting channel between two lake-basins, many instances of which I have noted amongst the lakes of the existing Tarim.

Want of water compelled us on March 22nd to make direct for Altmisch-bulak. Accordingly we continued towards the north-east between the jardang ridges, the going being now in every way excellent; for we had not so much as a single threshold to cross over. After we left the short patch of forest behind us at the truncated piece of river just mentioned, *kötäk* became exceedingly scarce, in fact it was conspicuous by its absence. Only in one spot did we come across a few living *jantak*, a scrub plant which camels, both tame and wild, are very fond of. In the more sheltered places slight traces of glittering white salt now began to make their appearance pretty frequently, and in such places the clay surface was generally somewhat granular. The reason that saline crystallisations of this kind had hitherto been so rare was, no doubt, that they had been planed away by the wind, as also that the lake, at any rate in this part, had contained fresh water, as may readily be inferred from the vast quantities of mollusc-shells which everywhere occur. But when the inflow was cut off from it, and it was condemned to dry up, its water would of course assume a certain degree of salinity. In fact, the circumstances which then supervened were the same as those which exist now in the case of the Kara-koschun, in which those parts of the lake that lie at a distance from the mouth of the inflowing river, as well as those parts which are relatively cut off from the main body of the lake, are frequently so salt that the water is undrinkable. When crossing the basin of Lop-nor later we encountered areas in which the water had manifestly been strongly impregnated with salt; for one result of the wind-erosion is to bring to the surface fresh underlying saliferous layers of the clay. The causes of these saline crystallisations showing themselves thus preferably in the northern parts of the desert may have been the relatively greater humidity and the relatively heavier precipitation in the neighbourhood of the mountains.

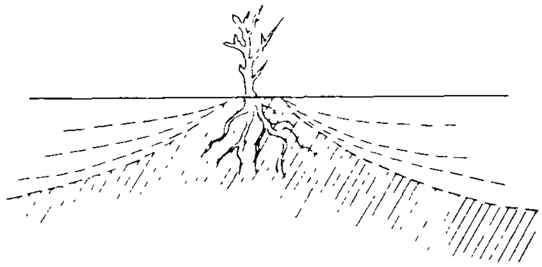

Fig. 64. FORMATION OF A JARDANG BY A POPLAR.

Here again we came across pieces of a very large vessel of burnt clay, as hard as stone, with thick sides and small handles, and of a greyish blue colour. We picked them up close to some big toghrak-trunks, the only ones we saw in this direction; no doubt a hut or homestead once stood under their shade. Still there were no signs of dunes; nothing more than an occasional very thin layer of sand behind some sheltering jardang. On the northern outskirts of the clay desert the jardangs now began to appear in two distinct superimposed stages or storeys, though of the upper stage, which rises 2 to 3 m. above the level of the lower one, not much is now left beyond a few fragmentary patches in the form of blunted cones or platforms. The lower stage, which lies about 2 m. above the bottom of the depressions, occupies naturally a much more extensive area. At length too we could just make out in two or three places indications of a third storey, there being in one locality a dome-shaped elevation of clay about 12 m. above the bottom of the adjacent depressions. All three levels of the clay desert are distinctly developed in the east. But to this subject I shall return at length lower down.

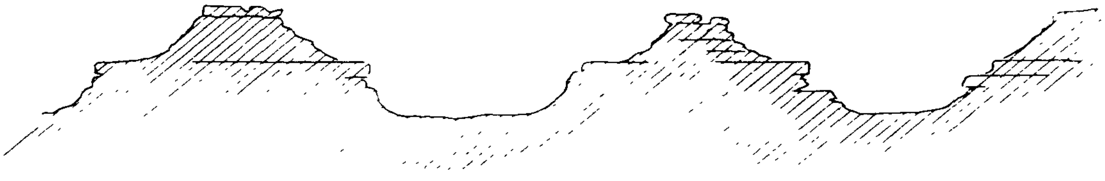

Fig. 65. DIFFERENT STAGES IN THE CLAY TERRACES.

But upon approaching the mountains, we found that the jardangs became fewer. The surface was covered with coarse sand and fine gravel, the products of disintegration, and the desert changed imperceptibly into a gently ascending saj, dotted over at first with table-topped elevations of clay, though these soon came to an end. The first firm hills we reached at the foot of the mountains lay at an angle of 30° S., and consisted of clay. The first solid rock we encountered, a species so severely disintegrated as to be unrecognisable, lay in the position 40° N. 50° W., and this situation it maintained for a long distance, the heads of the layers being parallel to our line of march, and cropping out south-east through the detritus. These heights are however very inconsiderable, being little more than paltry hills, destitute of settled arrangement; in fact, they are virtually rounded knolls and protuberances of the surface, the ruins of once mighty mountain-ranges. Very often they afford, to the south and south-east, wide views over the boundless desert ocean, the details of which were then lost in the haze. After a slow climb of about an hour, we reached the top of a broken plateau, plentifully strewn with coarse gravel and furrowed by a number of dry rain torrents, all running towards the south-south-east.

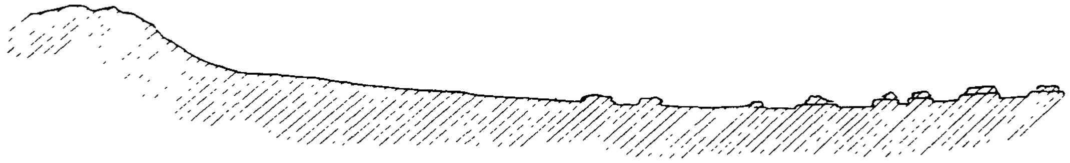

Fig. 66. VERTICAL SECTION BETWEEN CAMPS XII AND XIII.

A large glen, pointing towards the S. 35° E., and inclosed between walls of naked rock, its dip being 12° N. 40° W., was reported to be the lower part of the glen of Olun-temen-tu, in the upper part of which is the spring of the same name.*

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* Kosloff writes the name incorrectly Oluntimentu and Grum-Grschimajlo puts it even more incorrectly as Ulan-tamanta. The word *temen* is Mongolian for »camel»; *olun* = »a large number», »many»; while *tu* is said to indicate in this particular region »a small spring». Thus the spring in question is one that is frequently visited by wild camels. According to Kosloff, the name is also applied to the mountains around it.

After crossing over this deeply trenched ravine, we travelled hour after hour towards the north-north-east, across an expanse of detritus, in part undulating, in part level, absolutely barren and waterless, and ribbed by hundreds of tiny ridges or »corrugations» of solid rock, one or two decimeters high. It was in this dreary stony desert that we made Camp No. XIII, having travelled 38 km. towards the N. 26° E.

On the 23rd March we continued our journey towards the east-north-east, along the southern foot of a small, unimportant chain. Towards the south-east the surface sloped away without a break towards the clay desert, which was here not screened by any mountains. North, north-west, and west there were only insignificant ridges, and all at a great distance. I had imagined the Kuruk-tagh to be, at the least, a distinctly marked, sharply defined mountain-range, and instead of that found that it consisted here merely of the last severely disintegrated fragments of such. Somewhat farther on we caught glimpses of a rather higher range, though it was of no great altitude. The ground was gravelly and barren; it was very seldom we perceived any scrub, such as *köuruk* or *tschakende*. The strata cropped out like edgings on a level with the surface, with very shallow hollows lying between them, imparting to the landscape the aspect of miniature waves. The wind now blew at the rate of 11 m in the second, and the atmosphere was thick; it was quite easy to understand why the gravel lay loose, without any binding material: all the fine matter is blown away by the perpetual winds as fast as it is produced.

# CHAPTER V.

## GRUM-GRSCHIMAJLO'S JOURNEY ACROSS THE MOUNTAINS NORTH OF KURUK-TAGH.

Altmisch-bulak is a small and beautiful oasis in the midst of this desolate stony desert. It resembles a sharply outlined island, and, like Basch-toghrak, stands on a terrace a couple of meters above the circumjacent barren region. It measures 2760 m. in circuit, and its vegetation, which is especially luxuriant, particularly in the vicinity of the springs, consists, as usual, chiefly of kamisch and tamarisks, forming in places thickets so dense as to be impenetrable. The south-west margin of the oasis is crossed by a glen which comes from the north-west, and it is in its *thalweg* that the largest as well as the greater number of the springs are situated. The gully at Altmisch-bulak is very distinctly marked, especially by the dense thickets of kamisch which grow along its edges. Its bottom consists of gravel, and below the springs it was, at the time of our visit, in great part filled with pretty large and thick cakes of ice. I pitched my tent amongst the sheltering bushes, not far from Kosloff's camp, the situation of which Abdu Rehim pointed out to me 112 m. S. 60° E. from my own. Thanks to this point of contact, our routes admit of being combined and compared. South of the spring there is a small plateau or shelf of rock of a dark green, fine, crystalline variety, dipping 58° S. 30° E. On a minor shelf of this we found some pieces of brick, belonging to a furnace in which lead had been smelted, though when that was the men from Singer were unable to tell me; but they said they had discovered marks of an axe in the tamarisk-trees, and the wood of these had, in their opinion, been employed for heating the furnace, and to judge from the axe-marks, it could not have been so very long since the furnace was in use. Some pieces of the slag were still left. For my own part, I believe rather that these indications of human activity go back to a remote period,

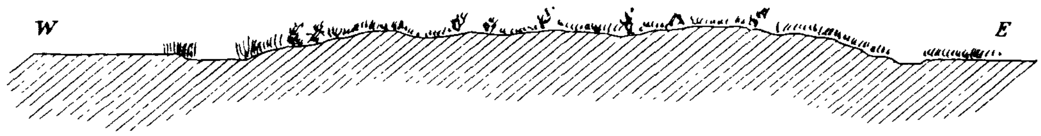

Fig. 67. VERTICAL SECTION OF ALTMISCH-BULAK (HEIGHT EXAGGERATED).

DRY WATERCOURSE AT ALTMISCH-BULAK

Ljustr. A. B. Lagrelius & Westphal.

ICE-SHEET IN WATERCOURSE BELOW THE SPRING ALTMISCH-BULAK

and that the axe-marks were caused by Mongol hunters. The name of Korghaschun-kene, or Lead-mines, mentioned above is a clear indication of the existence of lead-ores.

On the same plateau there occur pieces of a hard variety of rock, forming flat laminæ with a round hole in the middle, caused by the attritional force of the wind.

This oasis is evidently a favourite resort of the wild camel; indeed there were large troops there on both occasions when I visited it, on the present occasion, and again in the end of February 1901. There exists a superabundance of grazing, and the water of the spring is not too salt. At the end of February the ice-sheets were considerably bigger than they were in the end of March. We saw here both antelopes and foxes. The wild-duck rest at times beside these springs in the course of their migrations between the Kara-koschun and the regions to the north. Ticks, fleas, beetles, and spiders were already active in the end of March.

Fig. 68. WOUNDED WILD CAMEL AT ALTMISCH-BULAK.

The southernmost outliers of the little mountain-chain that lies to the north of Altmisch-bulak were visible from the spring to the N. 60° E., and due east we discerned in the far distance a yellow strip — the clay desert, where the former lake was situated. The desert appeared to be nearer on the east than on the south. Hence the old lake would appear to have bent round to the north-east, or perhaps there was a bay running in that direction. But with this topographical question I shall have an opportunity to deal lower down.

My guide from Singer computed, that from this spring to his native village was a journey of 6 short days or 4 long ones. In both cases every night can be spent beside a spring. The route goes *viâ* Olun-temen-tu, Teschik-bulak, Buru-tu, Bisch-bulak, Altschuk-bulak, Ojman-bulak, Nan-tschan (Nan-schan?), and Kara-koschun.

The name of Altmisch-bulak, meaning the Sixty Springs, is said to have been given to these springs because between Singer and that oasis there are that number of springs. It is more probable, that the name has been bestowed because it was supposed there are sixty springs in the oasis itself, »sixty» being used as the equivalent of a great many, just as the words for »forty» and »one thousand» are in the names Kirk-saj, Tschihil-sutun (pers.), and Ming-uj. Abdu Rehim also told me of the existence of three other springs without names farther to the east, and described to me their positions so accurately that on the following year, when I approached from the east, I was able, with the help of his directions, to find them out. I mention this to show, that the other information he gave me is no doubt equally trustworthy. Altmisch-bulak lies about equidistant from the three points — Jardang-bulak, Singer, and the nearest part of the northern shore of the Kara-koschun.

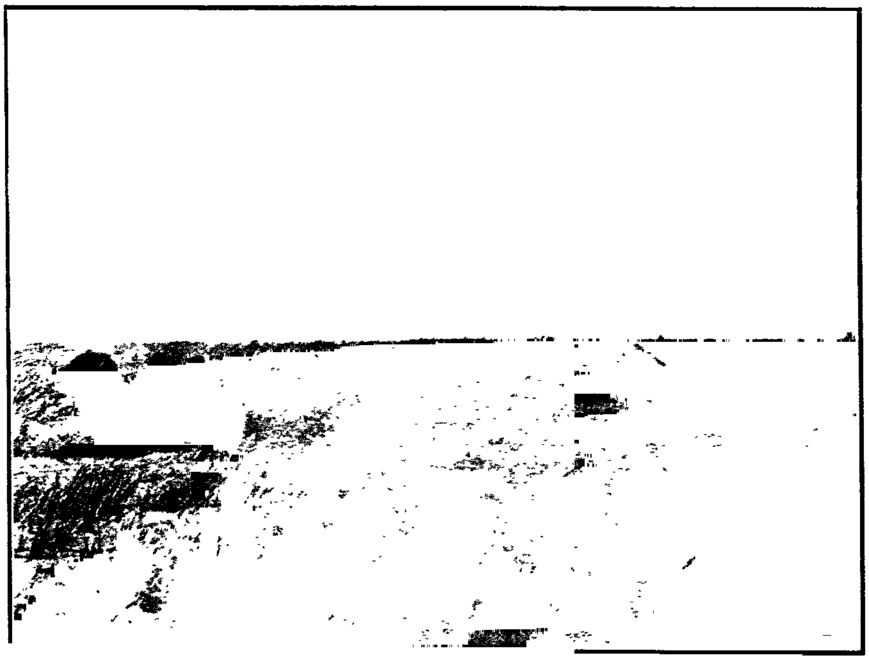

Fig. 69. WOUNDED WILD CAMEL AT ALTMISCH-BULAK.

Whilst marching along the foot of the Kuruk-tagh we ascertained that it assumes more and more an easterly direction. Beginning at Korla, it runs south-east, then east-south-east, towards the east from Jardang-bulak, and from Altmisch-bulak east-north-east. Hence it curves like a scimitar, and in this respect resembles the Kwen-lun and the Himalayas, and several other mountain-ranges of Asia. I will describe its eastern parts in a subsequent chapter.

I have already recorded the geographical names connected with the road from Jing-pen to Turfan and from Altmisch-bulak to Singer. My informant, Abdu Rehim, told me all the names he knew in the mountain districts around his home, but he added that there were many others lying outside the range of his hunting-excursions. It is impossible on the strength of this information alone to sketch even a provisional map, for his statements with regard to distance and direction are too uncertain, no distinction being made for instance between east, north-east, and south-east. It may however be worth while to record the names; they prove at any rate that there do exist springs in the Dry Mountains (Kuruk-tagh), and that the region in question is not absolutely barren. Here then is the list, which includes some names already quoted: — Mir-toktasun, Jätin-bulak, Schaldrang, Katar-julghun, Iltir-ghusch, Sindan, Mollamet-bulak; Tschöl-toghrakning-tege, a mountain-chain north of Bisch-bulak, said to be visible from Singer, although two day's journey away; Ghansechen-toghrak; Seri-tu, a spring about 10 or 12 km. north-east of Bisch-bulak; Ugen-tu, a salt-spring between the last-named and Muchlaj-bulak; Töruk-jangal, with salt-water, between Bisch-bulak and Kak-su; Soku-jangal, a spring, slightly salt, between Bisch-bulak and Altschuk-bulak; Sollak-aghis, with water almost fresh, one and a half day's journey east of Singer; the two springs of Sensulu and Usulu, half a day north-east of Singer; Tallik, with fresh water, three potaj west of Singer; Ak-bulak, with perfectly fresh water, three potaj south-west from the same point; Babam-bulak, also with fresh water, three potaj south of Singer; Bajin-otak, a fresh-water spring, 2½ potaj south-east of Singer; Oghri-bulak, one potaj north of Kara-koschun; Haghena-bulak, with drinkable water one day's march north-east of Singer; Kasan-bulak, with fresh water, half a day's journey east of the last-named; Kap-tschal-bulak, half a day north of Kasan-bulak, has drinkable water; Jan-bulak, salt, situated north-east of Kaptschal-bulak; Eger-davan,* a pass between Usun-bulak and Atschik-bulak; Jäti-davan, the district between Atschik-bulak and Tatlik-bulak, so called from seven low transverse ridges which exist there, Kusch-öji-davan, a

Fig. 70. ANOTHER VIEW FROM ALTMISCH-BULAK.

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* Evidently the same place as that called Egertschi in the preceeding account.

relatively high pass between Atschik-bulak and Luktschin, evidently situated in the mountain-range which Grum-Grschimajlo on his map calls Tschol-tau;* Ba-bulung, a salt spring with vegetation, encircled by mountains; Atschi-tagh, a region in which wild camels are said to be plentiful; Siksan-bulak (the Eighty Springs), said to be 3 long days' march south-east of Luktschin, the track running through nothing but desert the whole way; Tägirmän-taschi, a mountainous district, three days south-east from Luktschin, where in 1898 a mineral (rock-crystal), is reported to have been discovered which the Chinese employ for making spectacles; Bir-ataj, due west of Siksan-bulak, a spring heavily charged with salt, which wild camels are fond of visiting; Köbrük, one day south of this spring; Julghun-bulak, 3 potaj south-east of the same, with water slightly saline; Saj-bulak, one day south-east of the last-named, which sometimes has drinkable water; Usun-bulak, one day east of the same, with very salt water; Setemse-bulak, one day west of Saj-bulak, yielding salt water at certain times only; Toghrak-bulak,** with fresh water, a long day's journey west of Setemse-bulak. From Altmisch-bulak it is said to be a short day's march northwards to Kuruk-toghrak; thence one day to the east to Ak-bulak; thence one day east-north-east to Otun-nodscha; thence half a day north to Pavane-bulaghi. Ak-bulak is said to yield copiously, but the water is salter than that of Altimisch-bulak; there too grazing is abundant, and there are plenty of antelopes. Kuruk-toghrak only yields water in years in which there is an abundance of rain and snow. The other two are salt. As a general rule, the springs may be considered to grow salter towards the east.

With regard to the orography, I gathered the following particulars. The track from Altmisch to Ak-bulak, a day's journey, crosses by an easy pass the mountain-chain which runs north and north-east from the first-named. On the other hand the portion of the same range which lies south of Otun-nodscha is more difficult; horses can indeed be used, but not tame camels. Kuruk-toghrak and Ak-bulak are both situated at the foot of identically the same main chain, which is however lower than the Kuruk-tagh at Budschentu-bulak, and has no connection with the chain at Singer. Both this range and the one north of Altmisch-bulak are stated to run east-north-east. This last, the southernmost of the middle ranges of the Kuruk-tagh, is said to be bigger than the parallel chains that lie to the north of it. Between the more distinctly marked crests there are said to be several parallel ridges of low elevation, all of them easy to cross. The main chain of the system is believed to pass near Singer, but it too is stated to be broken in several places: for instance, it is possible, I understand, to travel from Altmisch to Singer without crossing over a single pass. North of Ojman-bulak and Bisch-bulak there is stated to be the important, but broken, range of Tschöl-toghrak, clearly identical with Tschöl-tagh. South of Bisch-bulak there is also another broken range, terminating at Otun-nodscha. The country south-east of Luktschin is said to be a complete desert. And just as the spring water grows salter towards the east, so it may also be said, that in that same quarter the springs grow also fewer, as I indeed found to be the case later on in the eastern Kuruk-tagh. As a rule, too, the Kuruk-tagh grows increasingly lower in elevation from west to east, as well as at the same time increasingly broader. In fact, the system resembles a broom with the shaft pointing towards the west. I have already thrown out the suggestion, that on the route which crosses over to the Baghrasch-köl there are north of Suget-bulak only one range and one pass. The mountains of Chara-teken-ula, shown on the maps of Russian travellers, are probably identical with the Kuruk-tagh. If that is so, then it will be the two names, one Turkish, the other Mongolian, which have given rise to the idea that these are two distinct chains. Eastwards, then, this system spreads out into a number of ramifications, though the elevations of those in the extreme east are excessively small.

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* That is, Tschöl-tagh or Desert Range.

** All the springs which the Musulmans call Toghrak-bulak bear in Mongolian the name of Tora-buluk.

Such is in brief the information I derived from Abdu Rehim. With the view of throwing such light as is at present possible upon the little known region between the mountain ranges of the Tschöl-tagh and the Kuruk-tagh, I will cite a few extracts from the accounts which travellers have given of it who have visited that part of the world. The portion which immediately concerns us has only been visited by two travellers before me, namely Grum-Grschimajlo and Kosloff. Roborovskij crossed over the Kuruk-tagh at its extreme western end. Farther to the east, between Hami and Sa-tscheo-An-si, it has been crossed by several Europeans. This is not a history of geographical discovery in Central Asia; hence I shall content myself with quoting a few of these travellers. Finally I will describe my own journey along a line intermediate between Grum-Grschimajlo's route and the route connecting Hami and Sa-tscheo.

During the journey which the brothers Grum-Grschimajlo undertook in 1889—90 one of them, Michail Jefimovitsch, made an excursion southwards from Luktschin which is of especial importance, because it filled up a serious gap in our knowledge of the geography of Central Asia, and is excellently described by him in a chapter of his brother's book. Valuable though it is, I cannot of course quote it here *in extenso*, but must limit myself to a brief resumé.

The excursion was begun in the end of October (O. S.). The first station was Dga; whence three routes lead across the Tschöl-tagh — (1) an eastern one over the pass of Tasch-ua (ovo = obo?), to the spring of Paluan-bulak;* (2) a western one through the gorge of Urulscha-ause to the spring of Iltirghan; (3) a middle route, between the other two, leading to the same spring *viâ* the glen of Iltirghan or Iltirghutsch-ause. This was the route selected.

Immediately south of Dga the country is a perfect desert, sand and clay, together with gravel; salt crystallisations are common; and the land is excessively arid. Three versts south of Dga the traveller crossed over a large eroded watercourse, coming from the south-east (Tschöl-tagh) and proceeding to Assa. The shape of its bottom suggested the inference, that it carries water sometimes, though it may be it does not do so every year. Then the traveller struck into the valley of Iltirghan, which, running from south to north, is excessively desolate, being filled with sand and gravel. South of Chodscha-julghun the rocks consisted of sandstone, argillaceous schist, granite and quartzite; but hard rock is rare as compared with the products of disintegration. Towards its crest the forms of the chain become more and more rounded, and the relative heights much lower. The pass of Tschöl-tagh is situated at an altitude of 2958 feet (Russian). South of it, and approached by quite a short descent, lies a shallow open cauldron-shaped depression, saline and barren. It contains the spring of Kattar-scholghun (julghun) or Atschik-su (2667 feet), the water of which is strongly impregnated with salt. On the opposite side of it the glen of Schaldran opens out, where there exist long rows or colonnades of table-like elevations of sand and clay, one saschen high and crowned by tamarisks — what I have called tamarisk-mounds. There is no water there.

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* Also called Pavane-bulaghi, Pavan-bulak, and Palvan-bulak.

After that the ground becomes hard and lumpy. The mountains are disintegrated to such an extent that the traveller had great difficulty in procuring specimens of the different rocks for his collection. The surface grows more undulating, and the valleys which run amongst the hills are just as barren and desolate. They all lie east and west, parallel to one another, like waves of pretty much the same height. Thirty versts from Schaldran he came upon a small patch of green vegetation and fuel. Proceeding down the gently sloping depression, he suddenly discovered a deep, dry watercourse, issuing from the amphitheatre of mountains around, and running first west, then north-west, until it disappeared in the distance. Beyond this a shorter glen led to an extensive plateau, or rather a long, broad valley stretching towards the south-east. Then he passed a small kamisch oasis, with a rivulet of salt water flowing from it.

The little tamarisk oasis of Iltirghan is situated at an altitude of 3970 feet, on level ground, which is both saliferous and sandy. Its area amounts to ¾ square verst, and it is 8 versts long from east to west. South of it rises a mountain-range, which can be seen to extend six versts to the east, and then becomes masked by the undulating ground. In the same direction there appeared a cluster of dunes, built up of drift-sand. At its western end the valley is shut in by a mountain-chain stretching towards the north-west. Crossing this valley to the south-south-west, the traveller came to a low rocky crest, at the foot of which, in an extremely dreary district, is the fresh-water rivulet of Jätin-bulak. Between this rocky crest and another chain to the south of it is another valley, 6 versts broad and covered with soft detritus. Then came the deeply trenched ravine, 30 saschen broad, of Mil-toksun, with springs and an abundance of kamisch and tamarisks. In the same locality the drift-sand has been piled up by the north-east wind into a belt of dunes, 150 saschen broad and 4 versts long; they climb fully 500 feet up the slope of a ridge which appears to project in a linguiform shape from the mountain, and is covered with saksaul and other plants. Thence he descended into a valley or ravine some 5 or 6 saschen broad, extending north-west and traversed by a brook which loses itself in the sand. Here the kamisch grew very thickly and abundantly, and the trees in a toghrak grove there were as much as 70 to 80 feet high, which may be regarded as very unusual. This place is called Torak (i. e. Toghrak)-bulak, and is situated at an altitude of 4603 feet. Higher up in the valley the kamisch was 2 saschen (= 4 m.) high; which again may be considered unusual for kamisch not growing in a lake.

From this point the travellers saw in the south the imposing chain of Tuge-tau. A little above his camp here there were several large sheets of ice, and it

CAMP CLIV. FEB. 23RD 1901.

Ljustr. A. B. Lagrelius & Westphal.

WILD CAMEL SHOT AT ALTMISCH-BULAK

was from them that the river issued. It was evident, that after the snow thawed considerable quantities of water would make their way down to that place. The margins of the brook were well clothed with vegetation. Making an excursion up the glen, $1 \frac{1}{2}$ versts above his camp he struck into a large side-glen, which led him up to an undulating, plateau-like highland region, seamed with rain-water channels. At one place it occurred to him that he might be standing on the terraced shore of a former lake situated on the north side of the range. Thirty versts to the east there was an expanse of dunes.

The next camp, in the same valley, was at an altitude of 4954 feet, and had an abundance of poplars and vegetation. Tuge-tau is an imposing granite range, rising into peaks and domes, some of them being 4000 to 5000 feet in relative height. The mountains here are wild and inaccessible. He says: »Tuge-tau is the highest and at the same time the most inaccessible of all the chains in the system of the Tschöl-tagh. Its glens — ravines and gorges cleft in the solid rock — appear to be barren. There is said to be a spring at its eastern end, but it is difficult of access. North of this mountain *massif* is an undulating region, perfectly sterile, extending towards the east.» Grum-Grschimajlo considers, we see, that Tuge-tau belongs to the system of the Tschöl-tagh, though I for my part believe that this is orographically inadmissible. Judging from his and Kosloff's descriptions, and my own observations, the Tuge-tau would, on the contrary, appear to be the principal backbone of the Kuruk-tagh system, and it ought most certainly to be distinguished from the Tschöl-tagh.

A spring, which the traveller discovered at an altitude of 4723 feet, was named by his guide Urus-kijik-urdi-bulak (the Spring where the Russian Killed the Antelope); but he ascertained subsequently that its real name is Saate. It was surrounded by kamisch, and its water, which filled a pool 20 saschen long, was good to drink.

Continuing their journey southwards on 31st October (O. S.), the party crossed some yellowish grey hills of disintegrated diabase, and 5 versts from Saate surmounted a low crest, whence they perceived some imposing crags, rising 1000 feet above the stony desert, and exhibiting a darker coloration than the desert itself. The flanks were everywhere steep, except towards the east, where a low ridge or saddle, with a gentle upward curve, united this part of the system to other crags on the east. These last continued in the same direction until they died away on the eastern horizon.

After going 14 versts, he crossed, by a saddle-shaped pass, yet another rocky crest, which likewise extended to the east, though westwards it terminated in a depression with softly rounded sides. After that the country still continued to be undulating, the heights and ridges stretching from west to east.

After going twenty versts farther the party approached an even more important crest, from the summit of which they perceived, farther on, a broad, extended valley, backed on the south by a massive, but not very high, range, though it was evidently of considerable breadth. This, which forms the southern edge of the Tschöl-tagh system, is probably, according to Grum-Grschimajlo, identical with the range which on our existing maps is called the Kuruk-tagh. He was told, that on the other side of it there are no mountains, but instead there are the lowlands of Lop. This last range appeared to extend 40 versts to the west, and to grow higher and more rocky as it proceeded. On the other hand, the crest from which he viewed it grew lower towards the west. Eastwards, although the range of vision was more restricted, he was nevertheless able to see for 25 versts. Both the valley and the accompanying range bent, first towards the south, then towards the north.

In the valley between these two ranges lies the spring of Burup-tu at an altitude of 3500 feet. Its oasis has an area of 2 desjatins, and possesses two springs, a northern one with salt water, a southern with fresh water. As usual it afforded tamarisks, kamisch, etc., the first named being unusually vigorous and well-developed.

Leaving this spring on the 2nd November, the traveller proceeded up the valley to the east. After a march of 15 versts he came to a spot in which the more northerly and nameless range was pierced by a meridional glen, half a verst broad, the eastern wall of which was especially steep and lofty. A torrent, which originates on the northern face of the eastern part of the nameless range, makes its way through this transverse glen, and then proceeds towards the more southerly range (Kuruk-tagh). The glen on the east side of the torrent slopes a little towards the north. The nameless range turned out to be double, and of peculiar form, in that the southern wing is moderately low, and consists of unctuous clays of a blood-red colour, whereas the northern wing rises to a relatively great height. The valley between these two divisions lies far higher than the latitudinal valley between the nameless range and the Kuruk-tagh. In the vicinity are the spring of Teschik-bulak and an oasis without a name. There is also a second spring in the same locality, but the traveller did not visit it, and consequently did not see it; it bears the name of Ulan-tamanta, which, according to G. E. Grum-Grschimajlo, means the Red Dwelling-place. In reality it is the same as Olun-temen-tu.

Next he crossed the meridional torrent and travelled along the foot of the red range, and climbing over it, reached the valley between the two wings of the nameless range. The right-hand division slopes terrace-like towards the valley, and is furrowed by a number of water-channels, two feet broad and one foot deep.

As he advanced towards the east, the valley continued to rise, whereas the pass over the nameless range appeared to grow lower and lower in proportion as they approached it; and in fact he found it to be a deep-cut saddle. From its summit (3875 feet) they beheld below them on the other side an extensive oasis called Kuruk-taurak, or in Mongolian Chura-taurum,* or the Dry Place, down to which runs a dry sandy torrent-bed. By travelling up the valley that lies to the south of the nameless range one would reach Paluan-bulak, which is considered to be situated two days' journey due east, i. e. 110 versts from the spot where they then were, or 170 versts from Dga.

A more easterly route was chosen for the return journey to Iltirghan. After travelling six versts through a valley with a gravelly bottom, running between low heights, the party came to a crest, and over on the other side of it found an extensive cauldron-shaped valley. Although the mountains in that part were not high, they were yet higher on the west than on the east. To the north lay a high crest, terminating in a deep-cut saddle; this was evidently the eastern continuation of the range which lies south of the spring of Urus-kijik-urdi-bulak. The bottom of the cauldron-shaped valley was hard. There was said to be a spring near its western end, the name of which was not known to Grum-Grschimajlo's guide. The range with the deep saddle-pass is situated 17 versts north of Kuruk-taurak. North of it again lies a latitudinal valley, 5 versts across, which was lost to sight towards both east and west; but on the north it is bordered by a fresh range, which he likewise crossed by a pass deeply notched in the crest. This range is rocky; it forms the eastward continuation of the Tuge-tau. Ten versts beyond this chain occurs the broad expanse of sand, with large sand-dunes, which they saw on the journey out. These dunes are in part bound together by saksaul, and in some places are so high that they overtop the low range which stretches north-west on the northern edge of the sandy expanse.

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* But Kuruk-toghrak means the Dry Poplar, and *taurak* and *toghrak* are the same word.

North of the Tuge-tau the country becomes increasingly poorer in vegetation, its aspect generally growing increasingly more lifeless. The rocks too are fewer, their place being taken by rounded, disintegrated ridges. After a march of 60 versts, in great part through an interminable gorge-like passage-way, from which it was not possible to see anything of the adjacent country, they at length reached the spring of Iltirghan. Grum-Grschimajlo concludes in the following words: »Thus it can no longer be said that the extensive region between Turfan and Lop is a *terra incognita* . . . . its aspect is quite different from what in our imagination we painted it. Instead of being a desert, Ghaschun-Gobi, partly gravel partly sand, it is in reality an extensive mountainous region.»

On the basis of his own and Prschevalskij's itineraries, Grum-Grschimajlo calculated that Teschik-bulak ought to lie one degree north of the inundation area of Lop-nor (Kara-koschun); and that is approximately right.

The highest altitude on the line of route followed by the traveller was in the Tuge-tau, where the relative altitudes are at least 4000 feet, the absolute altitudes 9000 feet. He continues: »This is certainly the highest point in this mountainous region; but it must not be forgotten, that I was only able to explore a very narrow zone, and that not a few indications point to the existence of considerable altitudes farther east. At all events all the latitudinal valleys we crossed on the excursion slope down towards the west, and thither too all the dry torrents are directed, though it is only sometimes that water courses down them. The range of Tuge-tau acts as a water-parting. The crests and ridges which lie south and north of it exhibit, like the Tuge-tau itself, a predominant west-north-west strike, and divide the region into a series of long narrow valleys, several of them parallel to one another, which descend like terraces in both directions, that is to say on the one side towards Lop-nor and on the other towards the depression of Luktschin. The most typical, as also the largest, of these valleys are that of Katar-julghun and the valley which intervenes between the Kuruk-tagh and the nameless range. Not infrequently these latitudinal valleys are crossed transversely by ridges or spurs, generally elevations *en masse* of the bottom of the valley. In these cases there exist, on the east side of the transverse elevations, cauldron-shaped depressions, which some time or other have been the bottoms of former lakes, but are now salt-basins, e. g. the Iltirghan valley. The hydrography of the Tschöl-tagh country is likewise conditioned by these irregularities in the bottoms of the valleys. Most of the main streams, which flow here intermittently, do not descend the valleys directly, but cross them diagonally, and it is only after they have broken through one or more intervening ridges, that they turn west.» Then he cites certain instances of this, including the brook of the Teschik-bulak. »Gathering off the northern slopes of the nameless range, it breaks through this last in a meridional glen, crosses the next valley diagonally, and after picking up a torrent which comes down the same valley from the east, forces its way through yet another range, the Kuruk-tagh, and finally emerges upon the lowland of Lop.»*

Lower down, after noticing the other itineraries which I have to consider, I will endeavour to give an intelligible account of the orography and hydrography of this mountain-system. Measured in a straight line, Grum-Grschimajlo's route between Dga and Teschik-bulak amounts to 160 versts, and includes the full breadth of the entire system, with the exception of its border-range, giving us a capital and most trustworthy profile of three large ranges, the Tschöl-tagh, the Tuge-tau, and the Kuruk-tagh, as well as of a number of smaller ones. Unfortunately his map is drawn on too small a scale (40 versts to the inch) to afford a clear idea of the orographical formation. For instance, the rain-torrents are not shown, and there is nothing to indicate in which direction the latitudinal valleys slope. Strangely enough, the most southerly border-range, which he calls Kuruk-tagh, is depicted in heavier fashion than the Tschöl-tagh, and far heavier than the Tuge-tau, which according to my view is the main crest of the Kuruk-tagh.

Of the geographical names that he cites, several agree with those that I ascertained. For instance, he mentions Iltirghan-bulak and Iltirghusch. The latter I had in the same form, but the former was given to me as Ölturghan-bulak, or the Killing Spring. On the map we find Ulterghan, clearly the same word. Miltoksun ought to be, I was told, Mir Toktasun, being named after a man. Other differences in orthography are of no moment.

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* G. E. Grum-Grschimajlo, *Opisanije Puteschestvija v Sapadnij Kitaj*, I pp. 381—417.

# CHAPTER VI.

## KOSLOFF ON THE WESTERN KURUK-TAGH.

When speaking of the route between Lop and Turfan, which is now, although to a very small extent, coming into vogue again, I had occasion to advert to the geographical names which Kosloff found along it. Perhaps I may be now permitted to adduce certain passages from his description of this more westerly part of the Kuruk-tagh system, which no other European except himself has yet crossed over. He also started from the Luktschin depression. »In about the middle of the Luktschin cauldronvalley there is a salt-lake, Bodschante, the surface of which lies 320 feet (Russian) *below* the level of the sea. On the south rises the desert range of the Tschol-tagh, which, apart from a bold attempt of one of the brothers Grum-Grschimajlo, who penetrated into it in a very desert-like region to the south of the village of Dighaj (Dga), has been crossed by no European except those travelling along the great highway. So that an immense portion of the wilderness, stretching southwards towards Lop-nor and south-eastwards towards Sa-tscheo, has hitherto been shrouded in mystery, waiting for its explorer.»

Kosloff began his journey on 30th September 1893 (O. S.). »The first two days we kept along the Kara-schahr highroad, which, after crossing the sandy gravelly saj that slopes down from the mountains, enters the Tschol-tagh by a transverse glen. As we advanced to the south, the glen assumed more and more the wild and gloomy character of a gorge, into which the sun's rays seldom penetrate, and where even a faint shout awakens a reverberating echo.»

»This gorge was almost entirely destitute of vegetation, and contained very little water.»

»At the post-picket of Agha-bulak the gorge emerges from the high crags which crown the flat top of the range. Thence opens out a broad expanse of country right away to the southern horizon, although it still maintains the same desert-like character. Shortly after passing the picket of Usmedschan (Ütsch-mejdan = the Three Fields), we quitted the highway and turned south over the gentle southern foot-hills of the Tschol-tagh, and encamped. The southern slope of the Tschol-tagh is very steep and hilly.»

»On the following day we travelled at a rapid pace down the southern slope of the Tschol-tagh, threading its many low hills, and eventually entered a desert-like valley situated between the ranges of the Tschol-tagh and the Karaksil [it ought to be Kara-kisil]. The last-named also extends from west to east, but falls short of the former in altitude, and terminated east of our route in a desert-like plain. In the valley that parts the two ranges just named are the last traces of the desiccated lake of Kumuschi, known also locally as Kumuschin-tuse. On its northern shore, but more especially also on its southern shore, there are sand-hills, bearing some of them dead tamarisks, others living tamarisks». A little vegetation was found in the dry lake-bottom; this is in places converted into salt-pans, which when seen at a distance resemble lakes.

The traveller encamped beside the spring of Schor-bulak, at the northern foot of the Kara-kisil, water being obtained at the depth of a good saschen. At its eastern end the Kara-kisil terminates abruptly, and is succeeded by a broad flat ridge. After marching round this, they descended into the next following valley, called Kara-kisil-tuse. This, twenty versts to the south, is blocked by the dark range of the Egertschi-tagh, but east and west it stretched farther than they could see. There were no traces whatever of animal or vegetable life. »At length, continues Kosloff, »we reached the pass over the Igertschi-tagh, and almost without perceiving it attained its crest, whence we had a broad plain spread out at our feet on the south. This, which was pretty fairly clothed with vegetation, is called Tungus-lik (Tonguslik); there the wild boar is said to come from time to time. The altitude of the pass is about 5,000 feet above sea-level. The crest of the range rises to a considerable altitude, and is almost everywhere serrated. The range itself soon comes to an end on the east, but westward it extends a long way.»

Descending from the range, they, after passing a little ridge, came to Gensocholo, from the spring of which there issued a brook 3 versts long. The vegetation of this oasis, which lies on the route to Uschak-tal, consists of kamisch, tamarisks, and poplars. The valley of Gensocholo is bordered on the south by the crest of the Kisil-tagh, which in point of character resembles the ranges already described. It is high in the north-west, but towards the south-east becomes perceptibly lower.

»From the gentle pass of this range one obtains a magnificent view towards the distant south-west. On the other side of the outspread valley the lofty group of the Tscharajlik-tagh, or as the Mongols call it Sajchen-ula, towers up in the form of a high ridge peeping over the flat range of the Kuruk-tagh. To the west of it appear the dark summits of the curving range of the Kuruk-tagh itself.»

A march of 12 versts almost due south brought the traveller to the district of Podschunsa, in the valley of the same name. In the vicinity was a lead mine, then worked by a party of Tungans. In the middle of the valley of Podschunsa there is a little mountain group, with springs at its foot, which give nourishment to a belt of vegetation 5 versts in length. In the period just before the summer rains the little brook from the springs reaches down to the marsh at Tunguslik. West and east the valley is shut in by low crests and detached heights, and on the south by the main range of the Kuruk-tagh. According to the natives, it is at these springs and pasture-grounds at the foot of the mountain-group of Tscharajlik-tagh, that the Torguts (Torgod) are wont to spend the winter. The flanks of this mountain-group are so steep that it is impossible for either men or animals to climb up them.

»From the district of Podschunsa we directed our steps towards the south-east, until we came to the lead-mines of Kant-bulak, situated amongst the spurs of the northern slopes of the Kuruk-tagh. The mines are worked by six Tungans, who discovered them fifteen years ago.»

»For a very long time there has existed a road past these mines leading from Toksun to the country of Lop. As a consequence of the divisions of the Kuruk-tagh system, it is convenient to travel through, or rather amongst, these mountains without either ascending or dipping down into the depressions, for the track winds backwards and forwards amongst them until it strikes the new route which has been made comparatively recently from Kisil-sinir. On the following day we continued east along the foot of a ridge, which ran parallel to the Kuruk-tagh, and so reached at length the village of Kisil-sinir. This village is situated amongst the hills, at an altitude of about 4,980 feet above the sea, and 230 versts from Toksun.»

From this place Kosloff returned to Luktschin, to the north-east. After leaving the village, although the surface was broken, they soon entered a valley bordered by detached ridges on the north, and having rolling ground in the east. It is at the foot of one of these ridges that the spring of Pasa Begning-bulaghi is situated.

This route to Luktschin is of the same character as the route already described farther west. The desert plateau is in many places crowned by single mountains, ridges, and flattened heights, mostly disposed east and west. But on the parallel of the Kumuschin-tuse they found in front of them an extensive plain, sparsely dotted over with small conical hills. It was here that the route divided, one branch going to Turfan, the other to Luktschin. The latter turns away to the north-east, keeping along the sand-dunes and extensive saline depressions, until it comes to the little salt lake of Usun-bulak, situated at an altitude of 2,500 feet and fed by a spring stream carrying a fair amount of water.

»In front of us on the north is the range of Tschol-tagh, attaining on this route a breadth of 50 versts. Its southern slope is long, and descends a considerable distance down. It is thickly studded with hills and detached ridges having for the most part an east-west direction. Its northern flank, which is turned towards the cauldron-shaped valley of Turfan, is incomparably steeper and shorter. The summit of the pass of the Tschol-tagh on this route is 4,200 feet.»

»The track, 100 versts long, from Usun-bulak to Tatlik-bulak in the valley of Luktschin traverses a barren desert, and is only passable in autumn and winter. On the south side of the Tschol-tagh is the valley of Julghun-tuse, 20 versts long and 12 versts across; it is surrounded by high mountains and slopes towards the north-east.»

After that, in the middle of November (O. S.), Kosloff crossed the same range by a third route, the Turfan road. »The vertical section of the Tschol-tagh by this route is very like the vertical sections on the Kara-schahr and Luktschin routes, i. e. its northern flank is steep, and its southern longer and flatter. The elevation of the range decreases gradually towards the east. On the Turfan road the culminating point of the pass lies at 4,990 feet. On the flat southern slope of the Tschol-tagh there is a lofty crest disposed almost at right angles to the general direction of the main range. Its peaks exceed in altitude the highest peaks of the Tschol-tagh that are visible from the road; the peak nearest to us was called by the natives Kisil-ighis-tagh. Throughout the whole of the way the mountains are perfectly lifeless; and the only satisfactory camping-ground the wayfarer finds is at the little spring of Atschik-bulak, with a brook of not more than 2 to 3 versts in length and situated on the northern flank of the range.»

»Having crossed over the Tschol-tagh, we travelled 15 versts in a southerly direction until we came to the spring of Arpischme. This is situated in the same saline valley of Kumuschin-tuse as the springs of Schor-bulak on the west and Usun-bulak on the east. Here, owing to the presence of the fresh water, vegetation thrives capitally. This inviting little spot may be regarded as the second best station after Kisil-sinir, where the traveller may rest with his animals.»

»Upon leaving Arpischme we crossed over a lower part of the valley, where we met with salt deposits at intervals, and so reached a sandier tract, which gradually rose. Shortly after that the Turfan road ran into the Luktschin road.» From that point he proceeded along the road already described, until he came to the open valley of Kisil-sinir.

Kosloff was then anxious to explore the country to the south-east, using Kisil-sinir as a base. The first day took him down a dry torrent, bordered by mountain ridges of no great height. At a place called Kara-koschun the valley was enlivened by an abundance of vegetation and several freshwater springs.

»On the following day we crossed over the Kuruk-tagh by a transverse glen with a little brook flowing south», and forming cascades in a few places. In the summer it is no doubt incomparably bigger; its banks were buried in vegetation.

»Upon emerging from this transverse glen we found ourselves on an extensive valley, inclining gently towards the south. On its southern side the Kuruk-tagh appeared to be considerably higher than on the northern. To the east we perceived the summit of the Jumulak-tagh. On the south the valley in question is shut in by low detached crests and heights, and it is towards them that the dry torrent runs which forces its way through the Kuruk-tagh. Its water, which flows underground, comes to light again at a spring some 10 versts from the foot of the range in the district of Nan-schan. Beside this we encamped.»

»Thence we travelled south-east across a barren plain, situated 3,000 to 4,000 feet above the level of the sea and traversed in places by low detached ridges, stretching east and west. In the more inclosed places there are traces of an ancient road which crossed this plain from Kisil-sinir to Sa-tscheo, with cairns of stones (*obos*) at the sides.»*

On the fourth day of the excursion the traveller reached the district of Buru-tu and that which immediately follows it, namely Olun-temen-tu, where his route coincided with M. E. Grum-Grschimajlo's.

Shortly after that he struck the dry bed of the Kuruk-darja, which two days' journey to the west joins the old bed of the Kontsche-darja (i. e. the Kuruk-darja). On the way thither he encamped at Altmisch-bulak.**

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* This is evidently the road which ran through Lôu-lan, the ruins of which are described in another chapter of this work.

** From this we see that the river-bed at Altmisch-bulak, mentioned above, in which the springs gush out, comes from a pretty considerable distance.

Kosloff describes the »general characteristics» of the Kuruk-tagh in the following words. »Before leaving the oasis of the Sixty Springs I will add a few words about the range of the Kuruk-tagh, the eastern prolongation of which is visible from that spot to a considerable distance, as well as something about the plain which borders it on the south. This range is particularly flat, and rises to only a very slight degree above the plain* which borders it on the north, whereas it rises to an incomparably greater height above the southern plain, and consequently forms the border-swelling that intervenes between the former plain and the latter. Eastwards the Kuruk-tagh grows perceptibly lower, and, apart from the Jumulak-tagh, possesses no dominating peaks. The plain to the south of the Kuruk-tagh is very desert-like, and is studded in places with low, flat elevations,** with a predominantly east-west trend. Falling gently towards the south, it is seamed by numerous dry torrents, some of which get down all the way to the dry bed of the Kontsche-darja. Nevertheless it is but scantily supplied with water, there being only two wells at which it can be obtained, namely, Nan-schan and Asghan-bulak. The water yielded by all the other springs and wells is exceedingly salt, and has a most injurious effect upon the digestion; and in this respect it grows worse the farther one gets from the foot of the range.»

Then follows the description of the Kum-darja, which I have already given (*vide* p. 4); after that Kosloff continues, »Thus the principal object of the expedition was successfully achieved, and it only remained, on the way back to Kisil-sinir, to observe the ridges and elevations from which the southern plain (the detritus slope) descends, and to cross a second time the dry torrents which we encountered along the former route.»

He again visited Olun-temen-tu; and »from there continued to the north-west, sometimes approaching, sometimes receding from, my former route. The various heights were separated by valleys, more or less broad. These were destitute of life and in the case of those lying near to the Kuruk-tagh were covered with a thin sheet of snow. The lower-lying valleys, more deeply embedded amongst the mountains, were occupied by salt depressions, the crusts of which, it being winter, were then hard. In the summer the water which comes down into them off the mountains converts them into marshes, and there is even marshy ground in winter at the places where the springs gush out.»

»The route by which we returned was characterised in general by an absence of fresh water, by wretched pasture, and by the stony nature of the ground, the stones being sharp-edged, but also by an abundance of fuel.»

»On the third day we came in sight of the culminating peak of the Kuruk-tagh, namely the Tscharajlik-tagh, situated west of Kisil-sinir. Due south of this, at about 20 versts from its free outstanding peaks, is the Kum-darja, and south of that again the lifeless desert, extending all the way to Lop-nor.*** This it is only possible to cross in winter, with camels carrying a supply of ice.»

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* More correctly »plateau» or »tableland».

** By this he means the detritus scree at the foot of the range.

*** The existing lake of Kara-koschun.

»From the district of Kok-su we turned almost north, crossing several successive flat elevations, which increased in altitude as we approached the Kuruk-tagh. Having surmounted the highest of these, we descended into the dry bed of the Gansichin-toghrak, where we made our last camp in the desert. This torrent, like so many others in these mountains, does not travel very far, but terminates in the cauldron-shaped saline depression of Nan-schan-schor. This depression, which is 50 versts in circuit, is inclosed on all sides, and projects westwards like a bay between detached flattened heights.»

With regard to the spring of Ban or Bavan-bulak, Kosloff says, »It lies at the southern foot of the Kuruk-tagh and about 15 versts from Kisil-sinir». This spring must not be confounded with the well of Palvan-bulak already mentioned; that lies a long way to the east, although Palvan is the same word as Bavan, both meaning »hunter».

Finally, I may add what Kosloff says about the route from Kisil-sinir over the mountains to Jing-pen. In this connection, as indeed in every case where I quote him, I select only those passages which serve to elucidate the orographical structure of the Kuruk-tagh.

»In point of fact the extensive desert which stretches between the basin of Turfan and the basin of Lop-nor, that is to say the two broad swellings, together with an incalculable number of ridges, protuberances, and hills, which taken together form the system of the Kuruk-tagh, make up an entity to itself, sharply differentiated from the surrounding regions, save that it is divided into two by a broad valley with saline depressions. Alongside of the northern depression there is a plateau, not very broad, with a pretty steep descent towards the north, while the southern slope goes down by a series of step-like terraces, which characteristically enough are formed along the side of the Tarim basin. Both swellings grow lower towards the east, but westwards rise into lofty mountain masses. The whole of this exposed region has been subjected to the excessive destructive agency of the atmospheric forces, which have incessantly filed them, rent them to pieces, and blown them down, and then swept away the minutest particles in the form of sand and dust, and deposited them in the adjacent basin on the south. Hence this has been the scene of the changes which have taken place in the network of rivers that supplied Lop-nor with water.»

On 16th December (O. S.) Kosloff started again from Kisil-sinir, and journeyed south-south-west. »On the right was a high range, on the left a whole series of smaller ones. We proceeded up a valley between the mountains, brightened by the manifold variety of the ordinary desert vegetation. At no great distance away two mountains and their peaks were distinctly visible, the eastern one called Dindiosen, the western Muchursein. Both overtop the flat Kuruk-tagh, rising to about 5,000 feet above sea-level, though to the unaided eye their relative altitude is approximately 3,000 feet. At the meridian of Mount Dindiosen we turned off to the south and climbed over the flat crest of the Kuruk-tagh. Farther on the road descended steeply towards the desert, which however still continued to preserve its mountainous character. Leaving on one side some mountain ridges which we had seen to the west when on the Kum-darja excursion, we reached this old river-bed again on the third day from Kisil-sinir».*

Upon reaching Jing-pen Kosloff completed his several crossings over the Kuruk-tagh, in the course of which he did so much to unravel the orographical relations of the western part of its system. His account is open to various minor objections, especially on the score of want of clearness in the terminology he employs to describe morphological relations and the features of the physical geography. The dimensions of the different mountainous regions are not sharply differentiated the one from the other. The words »desert», »plain», and »plateau» are not kept separate, and are often employed without discrimination for one and the same locality. It is also difficult to understand in what way the mountainous country between the basins of Turfan and Lop-nor came to have anything to do with the changes which have taken place in the network of streams that furnished the Lop-nor with water. There is no need to take any such rivers into account at all, for the rivers which fed Lop-nor have their origin in a totally different quarter of Central Asia, and flow through the basin of the Tarim. The historical lake of Lop-nor has never received any influx from the north, except occasionally and for short periods (after heavy rains) through the torrents that course down the detritus slope, particularly the one which proceeds through Altmisch-bulak.

On the whole however Kosloff's description, especially as regards the structure of this mountainous region, is in agreement with Grum-Grschimajlo's. Kosloff also speaks of the two systems, Tschol-tagh and Kuruk-tagh, and in addition of a number of minor ranges lying between them and parallel to them. It is quite clear from his description that he regards the range at Kisil-sinir as the main range of the Kuruk-tagh, an opinion which, although I have not seen the range in question, I venture to share. Kosloff says that the lofty mountain-mass of the Tscharajlik-tagh, which rises from the flattened summit of the Kuruk-tagh, lies west of Kisil-sinir. It is probably the eastward continuation of this range which Grum-Grschimajlo calls the Tuge-tau. On the little map that accompanies Kosloff's *Lop-nor* the main chain of the Kuruk-tagh is also drawn through Kisil-sinir, or immediately south of it, as well as north of Teschik-bulak. Its south-eastward continuation beyond Altmisch-bulak is on the other hand pure imagination, as we shall see later on. On the other hand Grum-Grschimajlo makes the main crest of the Kuruk-tagh run a pretty considerable distance south of Kisil-sinir, and also south of Teschik-bulak. Had he travelled one day farther to the south, he would have come to a very different conclusion. That Kosloff is right in his interpretation of the facts can be seen on Grum-Grschimajlo's own map. The »range of Sinbir», which is entered upon it from hearsay to the north of Kisil-sinir, is identical with the main range upon which the Tscharajlik-tagh is situated; and the Tuge-tau is identical with Kosloff's main range of the Kuruk-tagh. So that in point of actual fact the observations of the two travellers are substantially in agreement. Kosloff's observation, that the northern as well as the southern part of this mountainous region decreases in altitude towards the east, but rises into lofty masses towards the west, is undoubtedly right on the whole. On the other hand Grum-Grschimajlo's experience, that all the latitudinal valleys that he crossed incline towards the west, suggests that there are exceptions to this general rule. It is probable that the latitudinal valleys are divided by several low transverse ridges or »thresholds», so that their streams are directed sometimes towards the west and sometimes towards the east, and occasionally they meet in pairs at a common centre, and break through one or other of the ranges, in a way similar to what we find in Northern Tibet, although there the relations exist on a far greater scale.

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* P. K. Kosloff, *Trudij Expeditsij Imp. Russ. Geog. Obschtschestva po Tsentralnoj Asij 1893—95*, vol. II, pp. 47—73. In the matter of misprints, this volume establishes a record. Five pages of corrections for 296 pages of text is rather over-much. On one page there are no less than nine misprints!

The name Singer has quite puzzled me. My guide, Abdu Rehim, used to talk incessantly about his native village Singer, and about his old father Ahmed Pavan, who had lived there many years with his four sons. When I found Kosloff saying how he several times enjoyed the hospitality of this same Ahmed Pavan at — Kisil-sinir, it naturally followed that this latter place must be identical with Singer, and must possess two names, Singer being the correct form; for Kisil-sinir is in any case incorrect. Nevertheless there exist other indications that these two names signify two different places. For instance, we find them both entered on Grum-Grschimajlo's map; consequently he was told — for he did not visit that part himself — that they were the names of two distinct places. Then we have Kisil-sangir and, due east of it, Sangir-urten. This last name is identical with my Singer, for it is sometimes called also Singer-örtäng (i. e. the station of Singer), because the Turfan-Lop road passes through it. By the »range of Sinbir» Grum-Grschimajlo means the chain of the Kuruk-tagh which lies near Singer, and which ought to be called the Singer range. A long way to the east of both Kisil-sangir and Sangir-urten Grum-Grschimajlo puts a third name Singim, inserted from hearsay; this can be none other than Singer again. On the map of the frontier regions of Russian Asia, which has been prepared by the General Staff of the Russian army, this last name, Singim, does not appear, and we find Kisil-sinir only; this is perfectly correct, but would be still more correct, had the name been written Kisil-singer. According to Kosloff, Kisil-sinir means Red Vein or Sinew. I was told that the name Singer means Heel, and is derived from the fact of a spur of the mountains there resembling a man's heel.

# CHAPTER VII.

## ROBOROVSKIJ, PRSCHEVALSKIJ AND FUTTERER ON THE KURUK-TAGH.

On Roborovskij's map of the south shore of the Baghrasch-köl both names Kisil-sangir and Sangir-urten are entered, the former to the east of the latter. Between the two runs a route-line, labelled, »route through Sangir-urten to Sa-tschou.» To the north of both we read »Kisil-sangir-tagh», which again must in reality be the main range of the Kuruk-tagh.

Roborovskij however both in his text and on his map distinguishes between two parallel chains. In November 1900 this traveller made an excursion from Korla to Uschak-tal, round the southern and eastern shores of the Baghrasch-köl, and between the first-named town and the western extremity of the lake, where the Kontsche-darja issues from it, crossed the extreme western part of the Kuruk-tagh. I will here cite his conception of the orographical relations.

»At its north-eastern edge the oasis of Korla touches the desert-like slopes, strewn with pebbles, which descend steeply from the adjacent Kuruk-tagh. At the farthest extremity of the oasis a road branches off to the south-east to the district of Kisil-sangir, five days from Korla. At that place, which lies in a broad valley between the mountain chains of the Kuruk-tagh, 150 Kalmuck families are settled, engaged in agriculture.* In the mountain Altin-tagh, two days to the south-west of the same place, there are gold and lead mines, Altin-kan, though they are now virtually abandoned.»**

»Shortly after leaving the oasis, we crossed a little south-easterly spur of the Kuruk-tagh and on the other side of it a valley, and then entered a gloomy defile in the mountains, inclosed by dark walls of crystalline rock, totally destitute of vegetation, except along the bottom and in the crevices at the sides, where a few bushes have insinuated themselves.» Near the summit of the range granite appears again, in places severely disintegrated.

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* This statement was subsequently corrected by Kosloff, who found nobody there except Ahmed Pavan and his family. There are Kalmucks however not very far away.

** During my 1896 journey I was given the following information about this place: »Die Teile des Kurruk-tag, ein Paar Tagereisen unterhalb Tjinalga, werden Tjong-altin-tag und Kitjik-Altin-tag (der Grosse und Kleine Goldberg) genannt; hier haben fruher Dunganen gearbeitet, nach dem letzten Dunganenaufstand aber ubernahmen die Chinesen selbst die Bearbeitung, verwenden aber nur sartische Arbeiter. Die Arbeit wird nur während des Sommers getrieben. Sogenannte *kans* oder Gruben werden einfach in den Betten von vertrockneten Bächen gegraben; aus dem ausgegrabenen lockeren Schutt und Sand werden die Goldkörner durch ein Sieb ausgewaschen.» (*Pet. Mitt.*, Erghft. 131, p. 71.)

»The ascent of the actual culminating crest is rather steep and stony, but not particularly difficult for pack-animals.»

»From the top of the pass I perceived a considerable expanse of mountainous country, stretching a long way towards the south-east in three ranges, all built up upon a flat granite base. I was very sorry not to be able to see the lake of Baghrasch-köl; it was hidden behind rounded heights belonging to the extreme northerly range. This stretches first east, and then north-east, and is called Chara-teken-ula and Kisil-sangir-tagh . . . . There we began the descent, at first on the open slope, then by a stony, pretty broad transverse glen which stretches almost due north.»

»The southern slope of the range is covered with a thin layer of disintegration products, which however increases in thickness as the foot of the mountain is approached. On the northern slope we observed bushes (*Epherda*, *Kallidium*, and others), not only at the bottom and in the side-crevices of the transverse glen, but also on the slopes of the mountains.»

»Emerging from the transverse glen, we found ourselves on the verge of an open plain, which extends north-eastwards farther than we were able to see. It is the lowlands of the Baghrasch-köl; but the lake itself was not yet visible, though we could easily see where it was by a belt of high reeds and a line of hills along the shore parallel to it, and bearing tamarisks.»

»At Kalmak-uldi lofty sand-dunes approach the Baghrasch-köl from the south, and then continue along its southern shore. Beyond them on the south appears the northern chain of the Kuruk-tagh, the Chara-teken-ula, gradually increasing in height towards the east.»

»There are no settled inhabitants on the southern shore of the lake. It is only visited by hunters, and sometimes by Kalmucks who live at the other side of the belt of sand, at the foot of the Chara-teken-ula, when there is not enough grazing for their live-stock in the mountains. The locality in which these people live is Kujdalik, situated close to the foot of the last-named range, almost 25 versts due south from the district of Kimur-chani. It is well watered by numerous springs.»

Fifteen versts east of that locality the dunes were of immense size, and south of them Chara-teken-ula was only indistinctly visible. At the south-east corner of the lake Roborovskij struck a trail leading from a Kalmuck settlement to Uschak-tal. In conclusion, he adds the following general information about the range.

»The mountain-range of Chara-teken-ula, the eastern part of which is known as Kisil-sangir, is not more than 20 versts from the south-east corner of the Baghrasch-köl, and extends east and west. Forty versts south-east from the same corner of the lake, a long arm of the mountains goes off towards the north-west, and finally becomes lost in the steppe; while the main range unites, five days' journey south-east of the locality of Toksun, with the range of Tschol-tagh belonging to the Tien-schan.»*

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* *Trudij Tibetskoj Ekspeditsij 1889—90*, vol. III, pp. 78—92.

From this account of Roborovskij it would thus appear that between the Baghrasch-köl and the Desert of Lop there are not, as is generally shown on our maps, two parallel ranges merely, but three. Still of this I confess I am not fully convinced. Roborovskij says indeed, that he saw three ranges stretching towards the south-east; but in taking a general bird's-eye view such as he did it is easy to deceive oneself, and what appeared to be three different ranges may in reality be ramifications of one and the same main range. He states that in travelling between Korla and Baghrasch-köl he only crossed over one pass. This does not of course prevent the torrents and glens, which run down on both sides from the main range in which the pass is situated, from breaking through a northern or a southern range lying parallel to the main range. In that case he would have mentioned them whilst describing his route, but he does not do so.

I also was told, that there is only one pass, that is to say *one* mountain-range, on the route from Suget-bulak and Kurbantschik to Baghrasch-köl; and the simple name Davan (= Pass) given to the pass makes it probable that there is only this one pass along that route. In another passage Roborovskij himself appears to entertain the opinion, that there is only one mountain-range, for he says: »The southern slope of the range is covered with a thin layer of disintegrated matter . . . . There are bushes on the northern face of the range.» — words in which he dwells upon the great difference that exists between the flank looking down upon Korla and that looking down upon the Baghrasch-köl. And still less trace of three separate ranges do we find on the picture which he gives of the orographical relations on his accompanying map; at all events the country traversed by his route-line conveys the impression of crossing over one range only, the conventional sign )( and the abbreviation Пер. (Перевалъ = »pass») indicating the place where he crossed the range. How little known and how puzzling the orographical features of this region are is illustrated by the large general map which is printed along with Roborovskij's and Kosloff's account of their 1893—95 journey.* On it the westernmost part of the Kuruk-tagh is shown as a single range, which soon divides into two chains that diverge rapidly from one another. Of these the more northerly bears little resemblance to Roborovskij's Chara-teken-ula, which on his own map he puts at 32 versts south of the northernmost point of the south shore of the lake, whereas on the large general map it lies only 15 versts distant. Roborovskij says that the eastern part of the Chara-teken-ula is called the Kisil-sangir-tagh; but on the general map we find that the eastward continuation of the Chara-teken-ula is Kosloff's Igertschi-tagh.** The real facts appear to be that the Igertschi-tagh is a detached and separate parallel range, and the Chara-teken-ula and Kuruk-tagh are one and the same range passing through Kisil-sangir. When Roborovskij's guide in 1890 (Pjevtsoff's expedition) declared, that the Chara-teken-ula extended as far as Kisil-sangir, he was nearer to the actutal orographical truth than he was during his expedition of three years later.

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* *Atschotnaja Karta k Trudam Exped. Imper. Russk. Geogr. Obschtsch. pod. Natsch.* V. I. Roborovskago.

** So too on the map of the Russian General Staff of the territories bordering on the empire in Central Asia — the Hami sheet.

In the passage which I have quoted above from Roborovskij, he says that Kujdalik is situated 25 versts almost due south from Kimur-chani on the shore of the Baghrasch-köl. On his map however he shows it 20 versts S. 30° E. from the point indicated. If the statement in the text were true, then the distance, likewise in a straight line, between Kujdalik and Gerilghan, the nearest point on the Kontsche-darja, would be only 32 versts. Hence both ranges ought to lie within this short distance; but this is not likely, for the Kuruk-tagh is quite a considerable distance from Gerilghan. Moreover Kujdalik is expressly stated to be situated at the foot of the Chara-teken-ula range, probably in a glen-mouth, where there is a brook; and it may safely be assumed that it is a good way from the mouth of the said glen to the crest of the range.

Precisely the same results are arrived at when we consider the *data* which exist for the region between the glen-mouth of Suget-bulak and the south-east extremity of the Baghrasch-köl. Here it is possible to demonstrate almost geometrically the necessity of positing the existence of only one main range. From Dilpar on the Kontsche-darja to the south-east corner of the Baghrasch-köl is a distance of 84 versts. From Dilpar to the mouth of the glen of Suget-bulak it is 30 versts (32.2 km.); and from the south-east corner of the Baghrasch-köl to Chara-teken-ula it is, according to Roborovskij, 20 versts. With regard to the remaining 34 versts we possess no information; but my guide and a Loplik, who had been to the pass, assured me that it was a good day's journey to reach it. If therefore we count this as ten versts less than the day's journey between Dilpar and Suget-bulak, or 20 versts, there remains a breadth of only 14 versts for the two ranges. From Kurbantschik to Davan it is said to be a two days' journey, probably even by a difficult route on which only a short distance can be made in a day. It may also be taken for granted that the transverse glens on the north side of the Chara-teken-ula can only be a little shorter than the transverse glens on the south side of the Kuruk-tagh, seeing that the difference in elevation between the northern plain and the southern — Baghrasch-köl lies at 896 m. and the Kara-koschun at 805 m. — is not very great. Consequently the whole breadth of the 14 versts are required for the northern transverse valley of the Chara-teken-ula alone; or in other words, the two ranges must be in actual fact one and the same, the Mongol name Chara-teken-ula corresponding to the Turkish name Kuruk-tagh. Since Roborovskij's excursion along the south shore of the Baghrasch-köl, both ranges have figured on our maps. On sheet No. 60 of Stieler's *Hand-Atlas* of 1891, that is one year earlier than the issue of Roborovskij's book, one range, the Kuruk-tagh, is distinctly marked, but in addition there is a low ridge, Churtuk-tau, placed close to the southern shore of the Baghrasch-köl. But this latter name is manifestly a distorted form of Kuruk-tagh. It is probably due to Wilkins, who as a member of Kuropatkin's mission to Jakub Bek (1876—77) paid a visit to the Baghrasch-köl, and then no doubt saw a range to the south of the lake and was told its name was the Churtuk-tau. Matusovskij and Nikitin however on their »Karta Kitajskoj Imperij» of 1889 also show two ranges, a northern, the Churtuk-tau, and a southern, the Kuruk-tagh, which diverge rapidly from a common starting-point immediately east of Korla, precisely in the way shown by Roborovskij and as they appear on

Pjevtsoff's general map,* on which the »Range Sinir» forms the immediate eastward continuation of the Chara-teken-ula.

After these various perplexing statements, it is quite a relief to turn to Prschevalskij's account of his ever-memorable journey to the Lop country. Briefly, clearly, and lucidly he gathers up his own experiences of the Kuruk-tagh in the following passage: —

»Before reaching Lake Lop we had to march due south and strike the valley of the Tarim at a point eighty-six versts distant from Korla. For some way the country has the appearance of an undulating plain, covered with a pebbly or gravelly soil, and totally devoid of vegetation, forming a belt twenty to twenty-five versts wide, more or less, running parallel to and at the foot of the Kuruk-tagh, a low, waterless, and barren range, forming the last arm of the Tian Schan in the direction of the Lop-nor desert. This range, as we are told, rises on the southern shore of Lake Bagarash, and after continuing for nearly two hundred versts to the east of Korla merges in the low clay or sand hillocks of the desert.»**

Here Prschevalskij says, quite correctly, that the Kuruk-tagh ought to be considered as the eastward continuation of the easternmost wing of the Tien-schan a range which on the map of the Russian General Staff bears from west to east the following names in succession — Bughur, Kok-teke, Bajdan, Terskej, and Chalik-tau, and in the extreme west under the name of Kok-schal borders the valley of the Tauschkan-darja. In this long range occurs also the peak of Kan-tengri (6890 m. — Friederichsen). From what Prschevalskij says about the Kuruk-tagh rising on the south shore of the Baghrasch-köl, it would seem that he regards it as a single range.

T. Douglas Forsyth, who visited East Turkestan three years before Prschevalskij, says with regard to this same lake — though his information about its eastern parts rests upon native evidence only — in his Introductory Remarks to Delmar Morgan's work, »It (Baghrasch-köl) is separated from the Lop district to the south by the Kurugh Tagh, a wide range of sandy and gravelly ridges, amongst the hollows of which the wild horse and wild camel breed. There is a road between the lake and this range, seven day's journey from Korla to Ush Aktal (Uschak-tal), and there is another along its southern side, between it and Lop, seven day's journey from Kara Koshun to Turfan.»*** Thus Forsyth too looks upon the Kuruk-tagh as a single chain.

From a glance at Prschevalskij's original map, or rather the maps which are attached to the English and German translations of his book,† it is also apparent that there is only one mountain-range shown, and that it forms the immediate continuation of the Tien-schan range already spoken of, the only break in which is the gorge of the Kontsche-darja above Korla. There are, it is true, several spurs on the east side of this picturesque gorge, but they are only ramifications of the most westerly part of the Kuruk-tagh, and are separated by minor side glens. Thus the confusion which has crept into our maps with regard to the orography of the western Kuruk-tagh is traceable to Roborovskij's mistake as to the real significance of the Chara-teken-ula, and in the light of Prschevalskij's information this must be regarded as a step in the wrong direction. The fact of both ranges appearing on Grum-Grschimajlo's map is attributable to the fact that, although his journey took place a year before Roborovskij's, his book did not appear until four years after the publication of the accounts of the *Tibetan Expedition.*

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* *Trudij Tibetskoj Expeditsij.*

** *From Kulja, across the Tian-Schan to Lop-nor;* translated by E. Delmar Morgan, p. 54.

*** *Ibid.*, p. 23.

† *Peterm. Mitteil.*, Ergänzhft No. 53.

Returning to the passages quoted from Roborovskij, his statement, that the actual ranges rest upon a flat swelling, is in accord with the descriptions of other travellers and with my own experience. It is very interesting to learn of the existence of an isolated sandy desert, Ak-bel-kum, on the southern shore of the lake, and to read the description of its gigantic dunes. South of this desert the Chara-teken-ula (i. e. the Kuruk-tagh) was only faintly visible in places by reason of the great distance, which is greater than it appears from Roborovskij's map. On the other hand, to judge from Kosloff's and Grum-Grschimajlo's accounts, Roborovskij's idea, that this range unites with the Tschöl-tagh five days south-east from Toksun, is absolutely incorrect. Both of them lay stress upon the general parallelism which prevails in this mountainous region.

My own views with regard to the structure of the Kuruk-tagh system are embodied in the accompanying little sketch-map. On each side of the big Juldus valley, the valley of the Chajdik-gol, there are two imposing main ranges of the Tien-schan, lying parallel and close to one another. They widen out however in one place sufficiently to allow of the existence of an important cauldron-valley, in the midst of which lies the Baghrasch-köl. The northern chain is continued eastwards under the name of Tschöl-tagh and the southern under the name of the Kuruk-tagh, the divergence between them gradually increasing as they proceed. The former of these two ranges marks the northern edge, and the latter the southern edge, of an east-west swelling, which, although not very high, is nevertheless distinctly marked and definitively bounded. On the north this swelling is bordered by several depressions, e. g. Hami and Luktschin, the latter lying 130 m. *below* the level of the sea. On the south it is bordered by the Desert of Lop and the valley of the Bulundsir-gol. On the crown of the swelling between the two border-ranges there are a number of smaller parallel ranges, crests, ridges, and chains of hills.

Farther east, where the great highway from Hami to An-si-tschou and Su-tschou crosses the Gobi, several travellers have traversed the eastward continuation of the ranges which we are now discussing, e. g. Sosnovskij and Piasetskij, Mandl, Carey, Prschevalskij, Grum-Grschimajlo, Roborovskij, Obrutscheff, Futterer and Holderer, and others. Roborovskij's route was farthest to the west, so that my own excursion, which I shall describe lower down, comes nearest to his route. Prschevalskij's third journey (1879—80) was taken between Hami and Sa-tschou, Carey's journey between Hami and An-si-tschou. Futterer's line coincides in part with Grum-Grschimajlo's and Obrutscheff's. His account of these regions is the best, but before considering it, I must first give a few brief extracts from the descriptions of Prschevalskij and Roborovskij.

Prschevalskij's journey was begun on the 1st June (O. S.) 1879, and consequently fell in the most unfavourable season of the year; in fact, he often travelled at night, so that a good deal of the features of the country escaped his observation, and the description of his itinerary is incomplete. Between Hami and An-si there exist two nearly parallel roads, both practicable for wheeled vehicles, a proof that the mountains along this route are of no great importance.

The first few days the journey led across sand and saline depressions. At forty versts from Hami all vegetation came to an end, and in front of the traveller lay the perfectly barren Desert of Hami, which occupies the space between Tien-schan and Nan-schan. »On the west this desert is connected with the Desert of Lop and on the east with the central parts of the great Gobi.»

»Along the line of travel we selected, that is straight across it transversely, this desert rises in the middle into a vast swelling (120 versts in transverse section), with an average of about 5000 feet above the level of the sea, and culminating in 5500 feet (1680 m.) near the well of Ma-lan-tschuan. On its northern and southern borders it is fenced in by the two divisions of the Bej-sän mountains, which however are of no great altitude. Between the northern edge of this swelling and the Tien-schan stretches a somewhat undulating barren plain, with an upward slope north and south. Southwards it slopes down from the foot of the Tien-schan, and having got down to its lowest absolute level (2500—2600 feet) in the oasis of Hami and the sparsely grown vicinity, it begins to rise again towards the mountains of Bej-sän, near which, beside the spring of Ku-fi, it attains again an elevation of 3700 feet. Similarly there extends from the southern edge of the middle swelling of the Desert of Hami, from the southern foot of the Bej-sän mountains southwards, a perfect plain, with a considerable drop (about 1000 feet) towards the bed of the Bulundsir, and from there right away to the foot of the Nan-schan it maintains the same absolute altitude of 3700 feet. It is on this last-mentioned plain that the city of Sa-tschou is situated.»

»Such are, broadly speaking, the main features of the topographical relief of the Desert of Hami, that is along its minor axis, a distance, reckoning from the southern foot of the Tien-schan to the northern foot of the Nan-schan, of little more than 300 versts. Our route from Hami to Sa-tschou measured 346 versts, and was traversed in 14 days, inclusive of two days of rest.»

»On the third and fourth days out from Hami the desert presented itself in all its wild and terrible reality. In that part it consists of a somewhat undulating plain, with occasional elevations of loess in the shape of walls, table-topped mounds, and towers* scattered over it; the surface is covered with gravel and pebbles. Of vegetation there is not a trace.»

At the salt spring of Ku-fi the road divides, one branch going to Sa-tschou, the other to An-si.

»Choosing the Sa-tschou road, we advanced about 20 versts along it, and then came quite unexpectedly upon the Bej-sän mountains. According to Chinese accounts, these mountains extend from Kara-schahr in the west, forming perhaps the eastward continuation of the Kuruk-tagh, and unite in the east with the south-eastern range of the Tien-schan.»

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* Compare the *jardangs* of the Desert of Lop.

»With but few exceptions, the Bej-sän mountains present the appearance of isolated hills or groups of hills, with a slight relative altitude (100 to 300 feet, seldom more), scattered without any regard to order over the lofty swelling (*circa* 5000 feet above sea-level) of this part of the Desert of Hami. There are no well-defined peaks amongst these mountains, although, as stated above, their general direction is from west to east.» With the exception of the bottoms of the valleys and the clefts in their sides, the mountains are perfectly barren. Here wild camels are met with.

»On the south side of these mountains there is a barren plain, 50 versts broad, without boundaries on either east or west. On the other side however it is bordered by mountains of the same character and altitude as the preceding. These too are called Bej-sän, and in all probability are a southern branch of the northern group. The route traverses these mountains for a distance of 40 versts.»

According to Prschevalskij, the prevailing winds at this season of high summer blow from the east and, though more seldom, from the north-east. Probably the same relations obtain in this respect as exist in the country of Lop.*

Thus we find Prschevalskij also dwelling upon the presence of a distinctly defined swelling, ribbed with chains of hills, whose relative height is quite insignificant as compared with their absolute height; they are however not continuous, but are disconnected in the same way as in the region which I visited. The route which Prschevalskij followed lay to the east of the eastern extremity of the Tschöl-tagh range. Thus the Bej-sän are plainly the continuation of the Kuruk-tagh. It is also evident from Prschevalskij's map that, in addition to the main ranges of the Bej-sän, there are various other unimportant stretches of high ground with an east-west direction. In a word, the orographical features are the same as in the other known parts of the Kuruk-tagh system.

Now we come to Roborovskij. During his 1893—95 journey he made an excursion from Chala-tschi (Chara-nor) of about 110 versts towards the north-west, across the Kuruk-tagh system. As his route lay at the most 120 and at the least 70 versts west of mine, I will, by way of comparison with my own observations quote at length from him, especially as his recently published book is rather inaccessible to the majority of geographers.

»From this place (a saliferous river-bed near Chara-nor), the surface rose gently towards the Kuruk-tagh, and after going two versts we reached a low ridge of red granite . . . which turned out to be about three versts across. On the other side of it was an immense valley, bordered along the foot of the ridge by a belt of high hills clothed with vegetation, and beyond these again, and equally parallel with them and with the ridge, stretches a low elevation, 3 versts broad, and consisting of red course-grained granite, excessively disintegrated. Farther to the north is a pretty high, short crest with sharp peaks; this I skirted on the west, travelling north-west. To the north-east we saw the extreme southern projections of the Kuruk-tagh, east of the meridian of the lake. Right across our line of march lay a little granite range, the extreme southern outlier of the Kuruk-tagh. We encamped at

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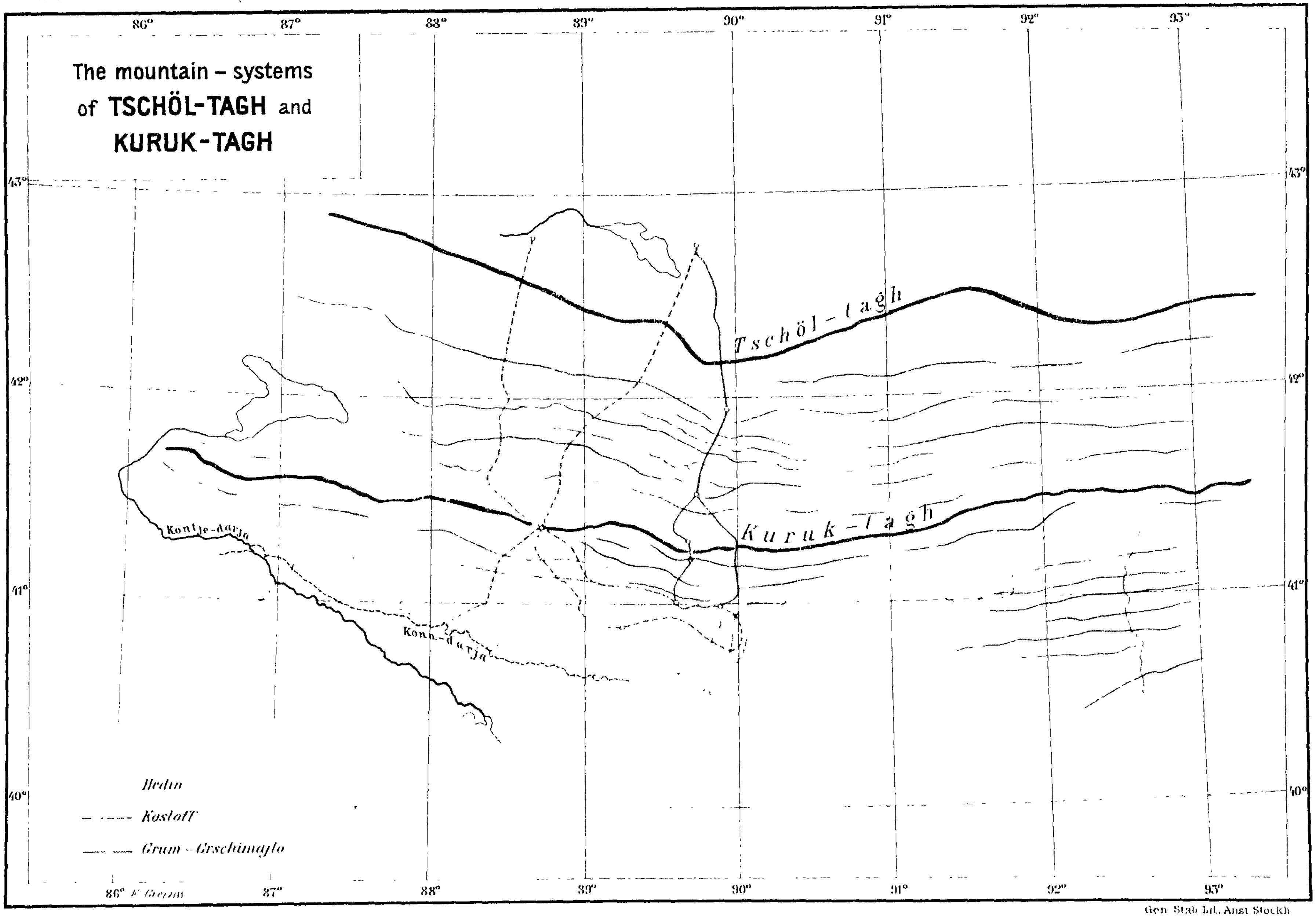
* Prschevalskij, *Is Sajsana tscherez Hami v Tibet na Verschovja Scholtoj Reki*, pp. 84—91.



Gen. Stab. Lit. Anst. Stockh.

its southern foot, at an altitude of 5280 feet above the sea. The crest, which was terribly cut to pieces, rose some 400 to 500 feet higher, not more, and presented no difficulties whatever in the way of a crossing.»

Next morning the traveller climbed to the top of the range. »Ahead of us to the north-west we found our path barred by yet another ridge. Selecting the very first depression in the crest, I made for it, crossing on the way a gravel-strewn steppe, followed by gently sloping foot-hills with rounded forms, and finally by an easy ascent reached a comfortable pass. This little range is built up of some variety of dark crystalline rock, whereas its southern slopes and the hills below consist of disintegrated grey granite. On the left of the pass the cliffs are piled up into solid masses, but on the opposite side the crest is lower and the outlines softer. Upon reaching the bottom of the pass, we followed a valley that inclines towards the south-east, until we came to another craggy mountain-group, with sharp peaks, stretching towards the north-east. Having passed round its eastern end, we found ourselves in a valley with a flat granite threshold, and shallow rounded troughs in the rock or small basins filled with water from the melting snow. The spaces between the troughs were occupied by greyish red gravel, a product of the disintegration of the adjacent rock, a rose-coloured, chloritic, porphyry-like granite. We crossed the next following crest, which was not very high and consisted of the same red granite and felsite, by an easy pass. The ravines and transverse glens were here choked with red sand formed *in situ*. On the other side of the range, in a tiny valley, we came upon an immense number of wild-camel tracks, showing that the place must be visited by them in troops.»

»On 10th February we had a mountainous road to travel. For five long hours we vainly sought to find our way across the range, which is rather craggy, and consequently difficult of access, especially as it does not run in any definite direction, but winds backwards and forwards like a snake, often bending round so as to be parallel with itself. In fact the range, which consists of varieties of crystalline rock, is precipitous and wild, and possesses an extraordinarily jagged crest.»

»After a difficult climb of 17 versts we reached the summit of the pass, and had before us an extensive plain, which showed here red, there yellow, and in other places almost black according to the coloration of the different varieties of rock that, in the form of sand and gravel, fill the hollows of the ground.»

»A long way to the north, at 60 or 70 versts' distance, there appeared yet another range, not very high, stretching north-east and of diminishing altitude towards the west. In that direction there extends a boundless level expanse, the surface of which slopes apparently towards the same point. Towards the east the elevation grows perceptibly higher.»

»The mountains from the top of which we obtained this extensive view consist of diorite and gneiss. Their transverse glens are filled with coarse granite sand. The pass had an altitude of 6637 feet above the level of the sea. Once, at some very remote period, it was crowned by an obo, and there ran a road over it to the south-west and north-east; traces of this can still be seen going in the latter direction. At first the descent from the pass was rather stony, but soon grew easier; it is about 3 versts down to the bottom.»

»After emerging from the glen, we proceeded north across a valley that slopes slightly towards the east, and so reached the highest point of a granite ridge, which runs towards the south-west, rising at the same time into cliffs of considerable elevation. Thence, after yet another glance at the valley behind us, we descended and encamped. According to my aneroid, this valley lay at an altitude of 4567 feet above sea-level.»

As the snow now began to thin out, occurring in small patches in sheltered spots, and as his horses were tired, Roborovskij thought it prudent to turn back.

He gathers up the results of his journey in the following words. »This region is a swelling, drawn out east and west, and having a breadth of 120 to 150 versts. Down the middle of it runs a long valley, 40 to 70 versts broad, the centre of which is nothing more than a stony desert. Its absolute altitude is about 4500 feet. On the north this valley is bordered by a zone of heights, likewise sterile, and known to the Turkish tribes of the vicinity as the Tschöl-tagh, meaning the Desert-like Mountains. Their average elevation is 6000 feet above the level of the sea. On the south it is likewise edged by small hills and ridges, the mean altitude of which exceeds 6600 feet above sea-level. The name given to these heights by the people of Lop is the Kuruk-tagh, meaning the Dry Mountains, that is they possess no water.»*

This summary description again emphasises the existence of the »swelling», as well as of low ranges rising upon it; and the two systems of the Tschöl-tagh and the Kuruk-tagh are sharply separated from one another by the long-drawn valley between them.

We now come to the last of the journeys which have to be considered in the present connection. In 1897 and 1898 Holderer and Futterer traversed Asia from west to east, crossing on their way the mountain system we are discussing. Their observations with regard to it are gathered up by Futterer in the following clear general account. He begins by pointing out, that there exists a broad swelling between the detritus slopes and gravelly screes of the Karlik-tagh and the Nan-schăn. It consists of granites, crystalline schists, and metamorphosed sedimentary rocks, greatly folded, of Archæan and even Palæozoic age. Several places in the same region afford evidences of volcanic activity, and there are various varieties of ancient volcanic products. Upon this swelling or pediment, which is identical with the P'e-schan (Prschevalskij's Bej-sän) run four more or less parallel ranges of varying altitude. Travelling from north to south, their route took them across the P'e-schan by —

»1). Ein hauptsächlich aus Granit bestehendes Gebirge mit ruhiger Kammlinie und mit vorgelagerten, geringeren Höhen aus steilgestellten Schiefern und alten Eruptivgesteinen. Höchste Gipfel etwa 300 m. über dem Fusse und 2300 m. über dem Meere.

2). Eine Gebirgskette mit zackigen, vielgegliederten Gipfeln, die vorwiegend aus Schiefern und umgestalteten, alten Sedimenten besteht. Höhe über dem Fusse etwa 400 m. und mehr; die höheren Teile liegen im Westen. In der 15 km. breiten

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* *Trudij Expeditsij Imp. Russk. Geogr. Ob. po Tsentralnoj Asij 1893—95*, vol. 1 pp. 164—169.

Depression zwischen diesen beiden Gebirgsketten ist eine starke Eruptions-Thätigkeit durch altvulkanische Gesteine in zahlreichen Hügelzügen und Gängen erwiesen.

3). Eine lange, kontinuierliche, nicht sehr hohe Gebirgskette aus alten metamorphen Sedimenten, hinter welcher bedeutende, granitische Höhen emporragen und die von zahlreichen, alten Eruptivgesteinen durchdrungen ist. Die Höhen in der Granitkette im Westen des Weges erreichen etwa 400 m. Im Osten, im Schiefer und metamorphen Gebirge liegen wohl auch höhere Erhebungen; im Westen des Weges aber ist nur ein höherer Stock zu sehen. Davon südlich folgen einige kleine altvulkanische Erhebungen und dann

4) eine hohe, äusserst zackige Bergkette, deren Höhe nach Osten zunimmt und die vorwiegend aus altvulkanischen Eruptivgesteinen und aus kristallinen Schiefern besteht. Auf der Nordseite sind ihr mehrere kleinere Bergzüge von derselben Beschaffenheit, aber unregelmässigerem Verlaufe vorgelagert. Die mittlere Höhe der höchsten Gipfel dürfte über 450 m. (2200 m. Meereshöhe) betragen. Auch nach Süden liegen vor diesem Gebirge noch kleinere, isolierte, altvulkanische Erhebungen.

Endlich folgen noch granitische Erhebungen 40 km. weiter südlich als Hügel-Zone mit derselben Richtung des Streichens, ohne besondere Höhe (etwa 200 m.), und noch weiter im Süden ragen isoliert in der südlichen, niederen Zone der Gobi die kleinen Schiefer- und altvulkanischen Hügel aus der Schotterfläche auf . . .

Es sind somit drei Teile der Wüste scharf unterschieden, sowohl nach physiognomischem Charakter an der Oberfläche als nach Entstehung oder geologischem Bau im Innern. Die breiten nördlichen und südlichen Zonen sind einander gleichwertig, sie bestehen aus denselben Gesteinsgattungen und haben an der Oberfläche dieselben Kieseinöden und Lehmablagerungen mit kulturfähigem Boden, da wo Wasser hinkommt. Die südliche Zone hat aber eine im Mittel etwas höhere Lage als die nördliche Niederung. In der Mitte erhebt sich aus den Wüsten des Aufschüttungslandes das feste Felsgerüste, gekrönt durch vier höhere Gebirgskämme mit kompliciertem geologischem Bau, welche auf grosse Entfernungen hin von West-Nord-West nach Ost-Süd-Ost dahinziehen als der steinerne Kern und das feste Gerippe der Felswüste Gobi, die in dieser ihrer Eigenart unter den Wüstengebieten der Erde einzig dasteht.»*

All these accounts which I have just quoted agree in their conception of the orographical structure of the mountain system we are considering. Roborovskij, speaking of its extreme western parts, describes the same flat swelling crowned by relatively low ranges that Futterer speaks of as characteristic of the system some 800 to 900 km. farther east.

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* *Durch Asien*, Bd. I, 208—210.

# CHAPTER VIII.

## THE AUTHOR'S OWN JOURNEY IN THE KURUK-TAGH.

I will now proceed to describe my own journey in the Kuruk-tagh system. My route lay, as I have already said, between Grum-Grschimajlo's and Roborovskij's second journey. I had crossed the Desert of Gobi not far west of Sa-tscheo, and had struck the Atschik-bulak, Toghrak-bulak, and a third small oasis situated to the north of the last-named, and thence proceeded towards the north. I had no intention of crossing right over the Tschöl-tagh and descending to the lowlands of Hami. I was solely concerned to find out how far the Kuruk-tagh range, which is so distinctly marked on our maps,* actually does exist, a thing of which I was very doubtful. At all events the portion of the range which lies east of Altmisch-bulak and north-east of Kara-koschun could not have such a pronounced south-easterly trend as it is shown to have on our maps, for this would ill accord with the statements as to its orographical structure which the travellers give of it. Another principal goal of my journey was Altmisch-bulak and the ruins I had discovered to the south of it the year before. In fact, it would have been much easier to have gone straight to Hami than to have crossed, first north, then west, an absolutely waterless country like that. We had to travel 328 km. without finding the least sign of a spring, and had we not by chance stumbled upon a small snow-drift our position would have been extremely critical. Here then if anywhere the name of Kuruk-tagh is justified.

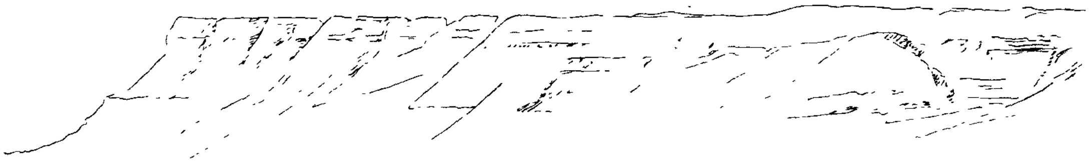

Fig. 71. CLAY TERRACE OF KURUK-TAGH.

We began this journey on 9th February 1901 at Camp No. CXLI, situated at the extreme northern edge of the belt of steppe and desert which extends from

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* See especially *Karta Juschnoj Pogranitschnoj Polosij Asiatskoj Rossij* — Hami sheet.

Pl. 6.

*Ljustr. A. B. Lagrelius & Westphal.*

CAMP CXLI, FEB. 8TH 1901.

Toghrak-kuduk. Only a short distance away begins the gentle slope which runs up to the sharply defined clay terrace that forms here the southern edge of the P'e-schan swelling (see fig. 71). On our right we left a detached portion of the same, resembling a projecting island in two stories. The soil between the edge of the zone of vegetation and the foot of the terrace is hard and strewn with gravel, and undulates a little. The terrace itself, which stretches in both directions as far as one can see, is on the top as level as a table, but its slope down towards the desert is on the contrary irregular, some portions of it shooting out like capes and headlands. It is also seamed by a great number of torrents and ravines, several of them pretty deep, and resembling gorges and »corridors». In places their ends gape upon one like gloomy portals. The only way to get to the summit of the terrace is by entering one of these and following it up to the top; the actual slopes themselves are much too steep to be climbed. At the point where we entered one of these ravines the terrace-wall was 35 m. high; if to this we add the height of the gently ascending saj, the total altitude is certainly 100 m. These trenches have been made by the occasional rain-torrents. Both they and the terrace itself resemble similar formations on the northern side of the Kuruk-darja. In both regions the clay terrace, or *sägis-jar*, as the natives call it, is a dominant feature in the morphology of the country. One is tempted to regard it as a surviving portion of the shore of the great inland lake, of which the Kara-koschun is the last insignificant remnant. The material is yellowish brown, and consists of grains of quartz but little rounded. Probably it is a loess formation, notwithstanding the fact that the peculiar loess characteristics are not so pronounced as usual.

Generally speaking, the clay is quite soft, and bedded horizontally. This applies especially to the top layer, which however is firmer and more compact than the less regularly arranged layers underneath it, and these it accordingly protects. We traversed the lower parts of this soft clay region by a gently ascending gully, which was absolutely destitute of vegetation, although there were clear indications that a stream had flowed down it at no very distant date.

The upper part of the little valley stretched down from the north-west. Leaving this on our left, we soon reached more open country. Here we were separated by some flat, hard, gravelly hills from another gully, which ran S. 71° E., and was channelled to the depth of 3 m. Besides this there were a great number of smaller torrents no doubt all of them accessory to the principal ravine, although they had a more south-easterly direction. The locality was reminiscent of the foothills of Altmisch-bulak, except that the hills and elevations which we had on both sides of us here were lower and less important than those at the spring. As yet our view was not impeded by the ridges in the vicinity. Southwards we could distinguish faintly the different zones of the lowland saj, steppe, and sand; but we could see nothing whatever of the low foothills which lie in front of the Astin-tagh.

Soon afterwards we entered a fresh glen, 150 m. broad at its mouth, which led us towards the north. In its bottom, which was level, with an extremely gentle ascent, were pieces of driftwood washed down by the torrents; but of living vegetation not a sign. In places there were flat patches of mud, deposited by sheets of stagnant water. Eventually the glen grew narrower, about 80 m. across. On both sides the mountains consisted of low hills, though at their bases the rock had been exposed by the action of running water. A glance east and west from the top of these hills sufficed to convince me that the country was undulating: such elevations as exist are so slight as scarcely to deserve the name of mountains. From both sides our glen was entered by a great number of side-ravines and subsidiary torrents of the very smallest dimensions, and in several places not more than 4 to 5 m. distant from one another. As a rule, there was sand in their bottoms. The side-walls of the main glen and of its larger ramifications seldom exceeded 8 to 10 m. in altitude. The marks in the bottom showed that the last torrent which poured down it had been shallow. At one sharp angle the side-terraces reached up to 12 or 15 m., and yet the glen itself was not more than 20 m. broad. Although the embedded driftwood increased in quantity, it was nowhere really plentiful; as a rule, it lay at the margins half-buried in the mud. The cliffs on both sides of the glen were persistently bare and naked. In two or three places there were concave hollows in them, bearing witness to the erosive force of the torrent, which in the narrower parts would appear to have filled the glen from side to side.

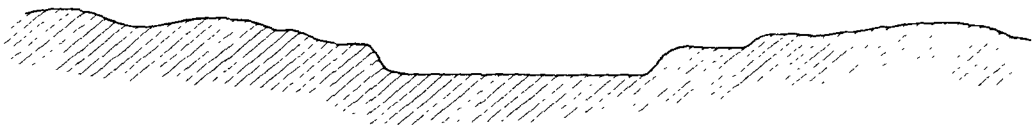


Fig. 72. VERTICAL SECTION OF THE ENTRANCE TO THE GLEN.

Above the sharp elbow that I have mentioned the glen widened out again to 150 m. On both sides the relative height of the mountain slopes was less than formerly, and the view was not at all restricted by the accompanying hills. In one place a small patch of clay was still slightly moist on the surface. At length the glen expanded to such an extent as to lose its character of an erosion trench, and resembled rather a plateau encircled by very low heights. We chose for our camping-ground a spot where there were tamarisks and scrub.

Upon starting from Camp No. CXLII, on the 10th February, we had two valleys to choose between, the main valley, coming from the north-west, and a side-valley from the north-north-east. The former looked the more promising, and the larger quantity of driftwood in its bed seemed to indicate that it would bring us to a region in which there was vegetation; and in fact a little way up it we did come upon an actual oasis, with well developed tamarisks, although in some parts the ground was white with salt. The kamisch was thin; but traces of wild camels were abundant everywhere.

Without knowing it, we had lighted upon an ancient road, which had possibly at one time been connected with the road which a little before that we had seen in the Astin-tagh (see vol. III). The day before we had found at the entrance of a small side-ravine, down in the lowest part of the glen, a piece of iron, 40 to 45 cm. long, with a foot attached to it: it appeared to have belonged either to a cooking-pot or to a brazier for warming with charcoal the tent of some Chinese or Mongol traveller (fig. 73 and 75). Its principal importance lay however in this: it afforded a sure proof, that the

Pl. 7.

*Ljustr. A. B. Lagrelius & Westphal.*

LOOKING WEST FROM CAMP CXLI; KURUK-TAGH TERRACE IN BACKGROUND.

road we had stumbled into was formerly used by Asiatic travellers. At the beginning of that day's march we noticed two or three unmistakable cairns of stones crowning conspicuous eminences, and in the little tamarisk oasis there were three stones evidently arranged to support a cooking-pot over a camp-fire, though there were no traces of either soot or ashes, so that a long time must have elapsed since the stones were last used for the purpose indicated. Higher up the cairns stood closer together, and when we reached a very faintly defined latitudinal valley, we perceived that the road bifurcated. To the west-south-west there were four conspicuous cairns crowning as many crags that jutted out towards the north, and similar cairns were visible to the north-west. The former road would seem to have run along the southern range of foothills of the Kuruk-tagh to the towns which anciently stood on the northern shore of Lop-nor; the latter to the neighbourhood of Turfan. Of the road itself there does not of course exist a trace; it is only the cairns of stones that betray its former existence. Some of them are much weathered, suggesting a great age. They consist generally of one or two large slabs of slate placed on edge, supported and surrounded by smaller stones (fig. 74).

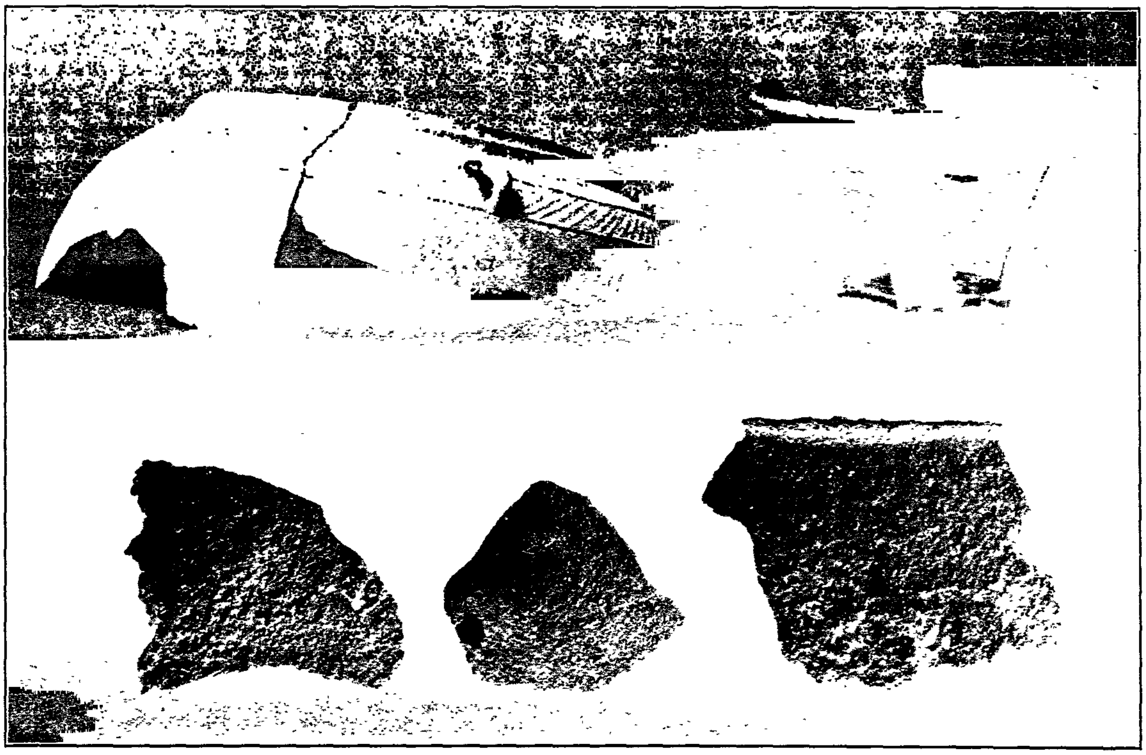


Fig. 73. FRAGMENTS OF IRON POT FOUND IN THE LOWER KURUK-TAGH.

Before us stretched from west-south-west to east-north-east a reddish mountain-range of no great altitude, its top approached by a very gentle slope. The pass, by which the old road crossed it, is so flat that it was only the shallow torrents which told us where it actually was situated, for the ascent and descent are hardly noticeable to the unassisted eye. To the north we now commanded an extensive view of an axial valley running parallel with the range last spoken of, and bordered on the north by another like it. The lowest part of the valley, which lay much nearer to the southern than to the northern range, was occupied by a level expanse of mud, thinly overgrown with scrub. From that the slightly undulating surface sloped slowly upwards to the foot of the next range. The ground was furrowed by a number of torrents large and small, all very shallow, but with their right sides rising higher than their left. The country was barren and desolate in the extreme. After crossing over two or three insignificant elevations, the farthest southern outliers of the range, we entered a glen, and encamped at a spot where a few snow-drifts, sufficient for our purpose, were still left amongst the tamarisks and other desert vegetation. Here there were wild camels.

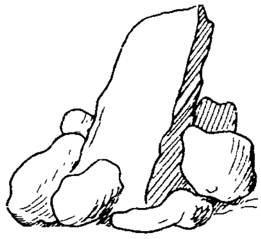


Fig. 74. A CAIRN ON THE OLD ROAD.

On the 11th February a pretty strong breeze blew from the north-north-east, and the sky was heavy with clouds; but we saw no signs of snowfall, either then or later. From the accounts of the Russian travellers whom I have quoted above, we gather the impression that a fall of snow is not an altogether rare occurrence, for three of them allude to it. Most of the snow that falls would seem however to dissolve during the course of the winter, and it is only rarely that sufficient survives until the spring to give rise, when it thaws, to running streams. The little patches of snow that we passed lay sheltered at the foot of a mountain-wall.

The distinctly defined valley led slowly north-north-east up to a considerable expansion, or rather an undulating latitudinal valley, the east and west extremities of which were screened by low hills. As the torrents gathered from every direction into the valley we were ascending, it was plain that the glen cut its way right through the range. The next chain to the north was somewhat higher than the preceding, and we could not attempt to cross it anywhere at hazard. Choosing a transverse glen that came down from the north-west, we soon found ourselves on the summit of a flat and easy pass. The northern flank of the range was set with numerous hills and seamed by numerous torrents, and after we had threaded these we came to another large open valley, stretching as usual from west-south-west to east-north-east. It was an absolutely barren region, a scrap of scrub being a great rarity: the soil was thinly covered with fine gravel, and the ground sloped imperceptibly towards the north. The torrents, which were quite distinct on the northern slope, were now gradually disappearing, the courses of only a few being still just observable as slight indentations in the ground. They looked as if they had not had water in them for several years.

This present latitudinal valley was also bordered on the north by a range with a steep slope towards the south. Although its strike ran due east and west, in both directions it appeared to come speedily to an end. After proceeding a short distance east along its foot, we turned up a short dry transverse glen, in which there was not a single trace of a brook. In its entrance, as indeed along the southern foot of the range generally, there were low dunes, formed therefore under the shelter of the north-east wind. It was a very stiff climb for our tame camels; though the wild camels, to judge from their innumerable tracks, thought nothing of

Pl. 8.

SUMMIT OF PASS (1535 M.). FEB. 11TH 1901

Ljustr. af B. Lagrelius & Westphal.

SOUTHERN ENTRANCE TO GLEN LEADING UP TO SAME PASS.

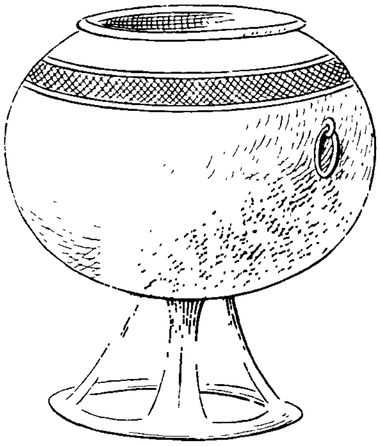


Fig. 75. THE SAME AS fig. 73, RECONSTRUCTED.

it. On the other side of the pass the descent was at first equally steep; but after a while we struck into a well defined dry watercourse, which, though in places like a narrow ravine, was nevertheless not so steep. It gradually swung round to the north-west and united with another transverse glen farther to the west. In these ravines there was a little sand also in sheltered places. The accompanying contour sketch shows the peculiar forms which this little mountain-range assumes (fig. 76). Its northern face is ten times as long as its southern, and the latter is of course proportionally the steeper. On the south the range lifts itself up abruptly from the plain; on the north it sinks slowly down to the next latitudinal valley.

On 12th February we crossed this valley diagonally, keeping towards the north-north-east. The valley itself extended from south-west to north-east, while the last of the ranges that we crossed over the day before inclined towards the north-east, or at least sent off a branch in that direction. The north-west face of this range was scored by a great number of brooks, but they were so slightly indicated that it was with difficulty we were able to trace them amongst the undulations of the surface. They appeared however to gather into a larger watercourse running south-west. To the west-north-west we observed a darker patch, presumably vegetation, for it was towards it that all the camels' and antelopes' tracks converged. Except for an extremely rare scrub-plant, the country was still absolutely barren. But the ground was not so hard as it had been; it consisted of a thin sheet of fine gravel strewn over an underlay of dust.

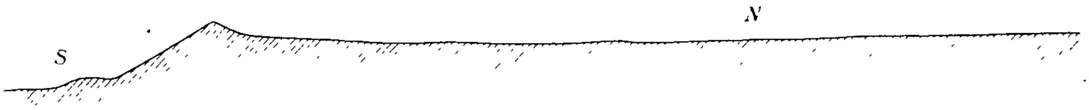


Fig. 76. VERTICAL SECTION OF THE MOUNTAIN-CHAIN.

Leaving behind us some small schistose hills, only a few meters high, we soon reached a fresh stretch of mountains, or rather a congeries of low hills, protuberances, and ridges, the ruins of a former mountain-range, the greater part of which has been denuded away. It was with difficulty that I was able to make out where its highest point was situated, the slopes were so extremely slight. The ground there was hard and strewn with gravel. On the left we passed a more distinctly defined, reddish ridge, while a long way off on the right were white and grey hills. On the north side we went down by a scarcely noticeable slope amongst the hills, and came into yet another latitudinal valley, resembling the former ones and parallel to them. There too the small rain-runnels were directed towards the north-west; though in the vicinity of Camp No. CXLV, but there alone, there was a pretty large and easily distinguishable dry watercourse running towards the north-north-east. It was also joined by another, similar dry watercourse coming down from the north-west.

The camp I have just mentioned was pitched on a sort of extremely flat water-parting, which therefore afforded an extraordinarily spacious view, without being to any noteworthy extent restricted by the low elevations around. Not a sign of life of any description whatsoever, still less any indication of a spring! It was in fact a lunar landscape, the awful desolation of which defies description. Towards the north the prospect was open, the surface being slightly undulating, with extremely low hills; probably we were able to see for 30 versts in that direction. By this the cairns or landmarks of the old road had come to an end, and we saw no other token of human presence.

As I believed I had now crossed the ranges which make up the eastward prolongation of the Kuruk-tagh, or more correctly speaking the westward continuation of the Bej-sän system, and as there was here the same level plain that we saw to the north, I deemed it prudent to turn our faces west in quest of the spring of Altmisch-bulak, from which we were at that time computed to be eight days distant. That was the only point where we could count with certainty upon being able to procure water, and as I had no guide — guides are not to be had in that uninhabited region — I durst no longer expose the caravan to risk, for to go to Hami lay entirely outside of my plans. On the 13th February therefore we travelled at starting towards the north-west, then curved round towards the west-north-west, and the west. We early passed several dry brooks running towards the north-east. Here we perceived some tamarisks and scrub-plants in a schor depression, which probably remains moist for some time after a shower. Farther to the west we approached the end of a mountain ridge more distinctly marked than the range last described, though it was not very high. It shed off however southwards from its crest several distinctly marked watercourses, the bottoms of which contained some gravel. Between these dry brooks the ground was slightly undulating, in fact almost level.

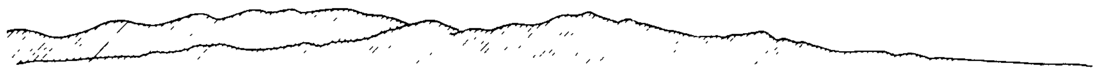
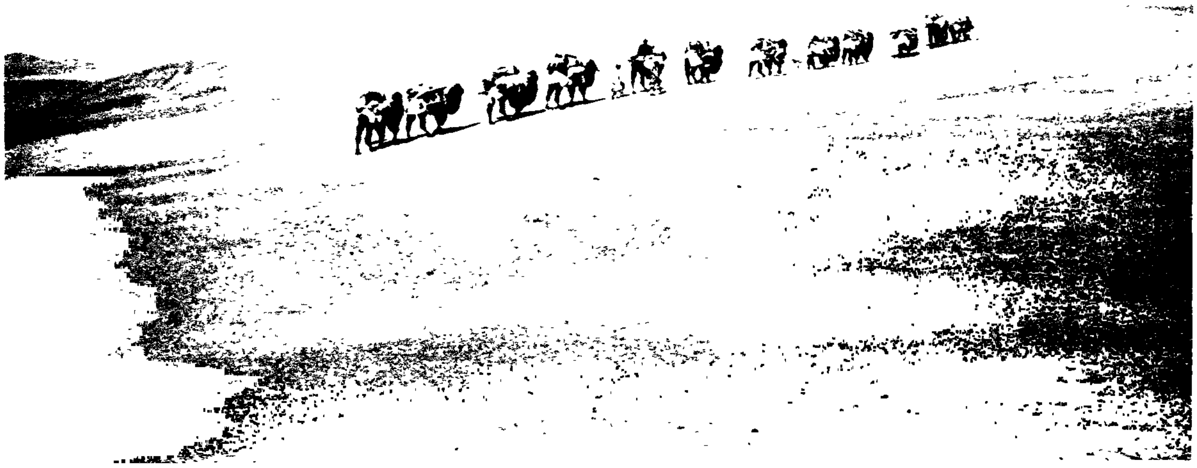


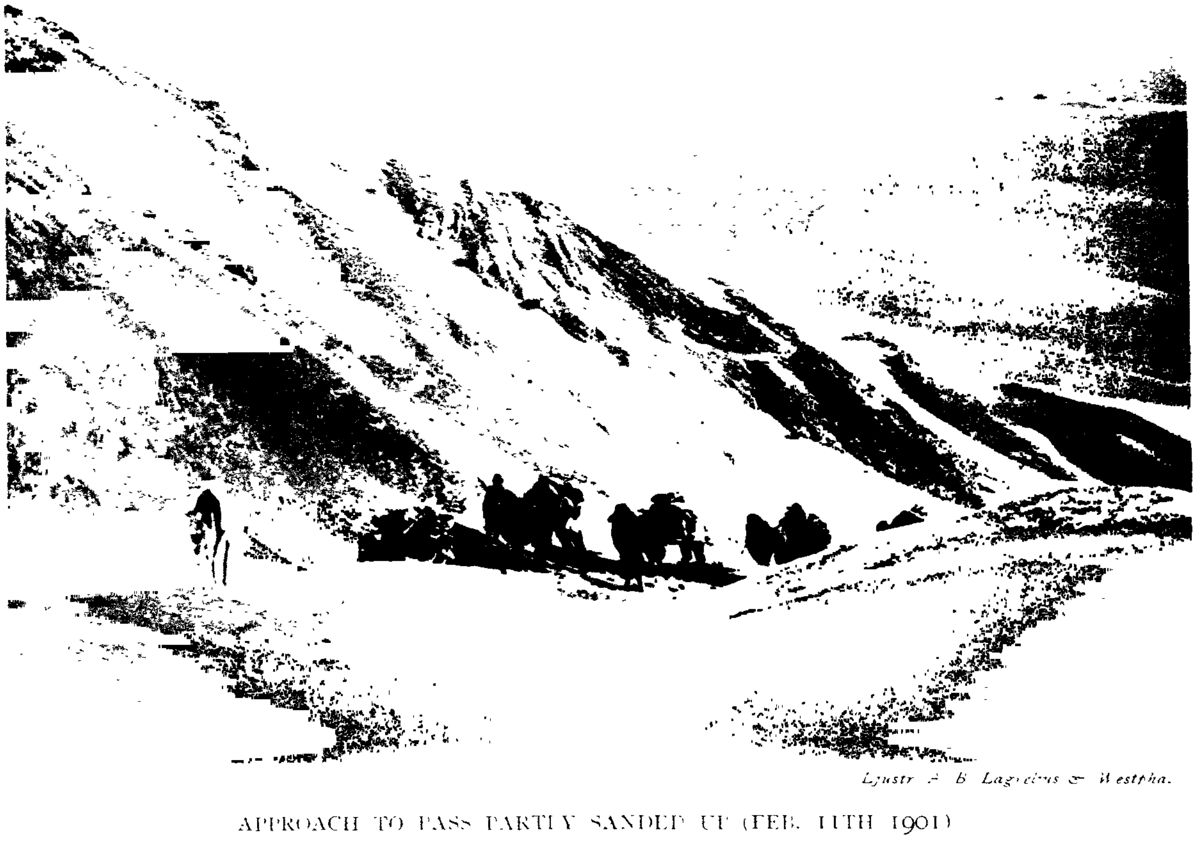
Fig. 77.

Thus in the course of our northward tramp we had crossed five successive parallel ranges; and of these the second was pierced by a transverse glen, the other four were each surmounted by a low, flat pass. It was at the foot of the sixth range that we made Camp No. CXLVI. On the whole these were of course the same ranges as those Roborovskij crossed over in the journey from which I have quoted above. Yet it is evident that these ridges and series of hills cannot be regarded as continuous chains of mountains. They are frequently broken, like the little range depicted on fig. 77. Roborovskij tells us that he skirted round the ends of two or three of them. Very often it is difficult enough to decide whether a series of these unimportant swellings or eminences should be called a true range or should merely be described as broken ground. This occurred at Camp No. CXLV. Anyway we had traversed the region which figures on Russian maps as the Ghaschun-Gobi or Ilchuma, and which is crossed from west to east by the Kuruk-

Pl. 9.



ON PLATEAU OF KURUK-TAGH.



*Ljustr. A. B. Lagrelius & Westpha.*

APPROACH TO PASS PARTLY SANDED UP (FEB. 11TH 1901)

tagh. But instead of finding a well-defined and considerable single range, a southern border-chain of the Bej-sän swelling, such as is shown on the maps, we had discovered, as Prschevalskij and Futterer did too, a flat swelling on the north side of the Gobi, diversified by a number of extremely insignificant ridges and lines of heights, stretching from west-south-west to east-north-east, and separated by broad, shallow, flat latitudinal valleys, which slope now in one direction, now in another.

Kosloff is probably the only traveller now living who has seen the whole of the eastern extension of the Kuruk-tagh from the south, namely when he journeyed from Abdal to Sa-tscheo. With respect to it he says, »On the seventh day (from Abdal), when at Panscha-bulak, we observed mountains on the north. Although the atmosphere was thick with dust-haze, we were able to make out pretty clearly the silhouette of the flat range of the Kuruk-tagh, extending from north-west to south-east. At Korot-bulak the range became distinctly visible. It now assumed a more majestic aspect, and inclined more to the east, though it is remarkably desert-like in character. Its southern slope, looking towards the route we were following, was free from snow. Generally speaking, this eastward extension of the Kuruk-tagh exhibits the same swelling as its western part, but the chains and ridges of which it is composed are alike more numerous and more massive than in the west. The system comes to an end in the Desert of Hami on the meridian of Chala-tschi. * The reason the mountains, when seen from Korot-bulak, appeared higher than in the west, was due simply to the fact that at this point Kosloff approached to within barely a day's journey of them. As an actual fact, they are a good deal lower than in the west. Kosloff was misled by the desert haze and his near propinquity to the range. The above quoted descriptions demonstrate conclusively, that the Kuruk-tagh, as compared with its neighbours, is in truth an insignificant chain; and its altitudes are the best proof that the term »majestic» is inappropriate to it. If any part of the system deserves to be called »massive», that part must be sought for in the west. The farther east you go, the more discontinuous and undecided grows the system, and the less massive you find that it is. Nor can it be correctly described as coming to an end at the meridian of Chala-tschi, for it is continued a long way east of the roads that lead from Hami to Sa-tscheo and An-si. The only difference is that the name Bej-sän (P'e-schan) is substituted for Kuruk-tagh.

On 14th February we travelled S. 54° W. through the same inconceivably desolate and inconceivably arid country; not a spring, not even a salt one, not a depression that exhibited signs of moisture! Such misguided plants as some time or other have struck root in these ravines appeared as if they had to wait years between their successive waterings; indeed it was amazing to find them still alive. On our left we had an exceptionally broad and flat latitudinal valley, the lowest point in which appeared to be about 5 kilometers distant. Its bottom was in places occupied by expanses of white dry schor. On the right, at the distance of two or three kilometers, was a mountain-group 50 to 70 m. high, gleaming in various shades of pink and white. Farther on, we travelled along the foot of a ridge which did not appear to be more than 10 m. in relative altitude. Then the surface became ex-

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* *Trudij Eksp. Imp. Russ. Geogr. Ob. 1893—95*, vol. II, p. 101.

tremely level, except that it was dotted over irregularly with a number of flat and disintegrated hillocks, generally one to two m. high, seldom as much as 3 or 4 m. Still farther on in the course of our 30 km. march we had on the right a little ridge that was both low and broken, and of a light red colour. On the left however the next elevation was so far off that it was only perceptible as a blurred mist. The latitudinal valley, which stretched between our route and the elevation in question, was, so far as we could see, perfectly level. At length we crossed over a part of it. It appeared to be a self-contained basin, the middle of which served as the bottom of a temporary lake. Here there was an immense expanse of *schor*, which had dried in polygonal cakes, with hard, sharp edges, cracks, and »ribbings» — excessively difficult and tiring ground to travel over. The material was saliferous clay, as hard as burnt brick.

It would be difficult to conceive a region more desolate and more monotonous than that which we travelled through on 15th February, a distance of 33.3 km. towards the S. 35°.7 W. This brought us only the very slightest degree nearer to the ridge that lay to the south of us; indeed it appeared to stretch on the whole pretty well parallel with our route. Such was however not the case with the chain on the north, a continuation of the pink and white range mentioned above. At the very beginning of the march we deviated from it to a very appreciable extent, and finally it disappeared entirely in the dust-haze with which, in consequence of the wind, the atmosphere was filled. The surface between these two lines of heights, which thus run at a very considerable distance from one another, is almost everywhere level and hard, and strewn with fine gravel. The region is absolutely sterile: not a scrap of windblown down! And it was very rarely that we noticed the track of a wild camel or antelope. Evidently we were here a long way from the nearest well; these wild animals only traverse these inhospitable wilds when migrating from one quarter to another. This desert leaves upon you an impression of even greater desolation and melancholy than the Takla-makan, where you can at least find something for the eye to do in admiring the noble outlines of the dunes. Here however, turn which way you will, it is the same »abomination of desolation» that greets your gaze. In which direction the surface slopes, it is often quite impossible to say. On the whole, it seems to incline towards the south-west, although so gently as to be imperceptible; but locally it inclines in every possible direction. Now we cross over a little dry brook running towards the north, then another proceeding south-west, and yet others going south, and others west. Thus they are in general both shallow and undecided in their course. Most of them look as if they had had no water in them for years. At rare intervals we would cross over a watercourse one meter deep, but in all these cases the containing banks were softly rounded. The little ridge to the south did not appear to be more than two or three score meters in height. We made Camp No. CXLVIII in a torrent, near some dried up scrub; except for this, the region still wore the same barren aspect as before. The wild camels' tracks ran generally north and south. In the former direction there is probably one or more springs amongst the mountains; in the latter there is grazing on the steppe.

Our march of 16th February led us across more broken ground, namely towards the south, the west, and the south-west. On the south we were accompanied by a minor range, which was however pretty broad. We reached the first saddle by means of a sandy watercourse; but after that had to cross over an entire series of spurs, branches, and ridges, separated from one another by small rain-channels. At length, however, we attained the summit, and then had a steep descent into a tolerably narrow latitudinal valley proceeding west. Southwards for as far as we were able to see — and the atmosphere was fairly clear — there stretched a long series of minor ridges; though to the south-eastwards the zone appeared to grow narrower, for in that direction, we could just perceive, beyond the last saddle, a faint yellowish gleam, indicating either the kamisch steppe or an expanse of sand. South-west the country was broken, and in the extreme west we could distinguish a mountain-crest. We had had some idea of trying to reach Tschigelik-kuduk, on the road between Abdal and Sa-tscheo; but as in the little latitudinal valley into which we had descended the wild camels' tracks were extraordinarily numerous, I thought it better to follow them westwards, for possibly they led to a spring. Accordingly we kept along the northern foot of the ridge that bordered the little valley on the south, crossing in succession over its numerous slopes and ravines. As however the ridge soon came to an end, and gave place to minor undulations, we bore more to the south-west, especially as the camel-tracks appeared to bend round to the north-east, possibly making for Pavan-bulak, a spring we had heard spoken of the year before; but it lay too far off our line of march, and the uncertainty of our finding it was too great for us to attempt to search for it. Two or three kilometers to the north-west we noticed stretches of low fiery red hills and table-topped elevations, which appeared to accompany both sides of the little valley we had left. In this quarter the crests of the Kuruk-tagh stretched east and west.

On the 17th February, after crossing over the broad range, and skirting round the western end of the other which lay south of the latitudinal valley, we directed our steps towards a projecting part of a third crest, which however came suddenly to an end like the others. A fourth and a fifth range both extended a little farther west, but both terminated equally suddenly. In other words, all these five parallel ranges came to an end in the same locality, although each successive range to the south stretched a little farther west than its neighbours. They were evidently the same lines of heights that we had crossed whilst travelling northwards from Toghrak-kuduk. At a pretty considerable distance to the west, and on the other side of a gap or saddle which was faced by the terminals of all the five ridges, we perceived a somewhat higher range, and, further, through a gap or notch in it yet another range, which appeared to be higher than all the others in that quarter. As the position of the caravan was growing desperate from want of water, we made straight for these mountains, where there was more likelihood of our finding a spring than there was to the south. For in that direction, as also to the south-west, lay the Desert of Lop, a gleaming yellow, barren expanse as boundless as the sea; and we knew from our experience of the year before that there was no prospect of digging down to water there. The *astin-jol*, or road from Abdal to Sa-tscheo, was too far off.

At first the ground was broken. On the right we still had the latitudinal valley, but it had now broadened out to a depression lying north-west of the terminals of the five ridges. Into it all the dry brooks of the vicinity gathered. The ground was very soft, frequently thinly strewn with gravel, with not a glimpse of vegetation either dead or living; even the wild camels' tracks were few and far between.

Upon reaching the western extremity of the third parallel range we changed our course towards the N. 70° W., keeping to the »mouth» of the valley I have mentioned. From the promontory already alluded to the surface dropped by several step-like terraces towards the depression. On the right we passed several hills of an intense brick-red clay with steep sides. The depression into which we now descended, after leaving all the outliers and promontories of the mountains behind us is, like them, divided into various zones of different characters and situated at somewhat different elevations. At the foot of the lowest terrace there lay what to the eye appeared to be a perfectly level expanse of *schor;* it consisted as usual of saliferous matter, and was hard, being roughened by corrugations 1 to 2 cm. high and seamed with small crevices. It extended towards the south-west for as far as we could see, until in all probability it merged into the precisely similar *schor* desert which I crossed later north of the Kara-koschun. It also appeared to extend to a considerable distance in the opposite direction, towards the north-north-east; where it was joined by the latitudinal valley which we had recently crossed over between ridges No. 1 and No. 2 and in which the camel-tracks were so numerous. This wedge-shaped arm of the Desert of Lop may be regarded as a bay of the larger lake which anciently filled its basin. On the other hand it is likely that the similar expanse of schor which we crossed immediately north-east of Camp No. CXLVII is an isolated basin, having no connection with this ancient lake; indeed its absolute altitude is considerably higher than the altitude of the latter. This wedge-shaped bay thus fills up the space which intervenes between the western ends of the five parallel chains and the ranges of the Kuruk-tagh to west and north-west of them. Consequently the orographical relations are quite different from what the maps have represented them to be. In this particular locality the southern chains of the Kuruk-tagh are broken off abruptly, whereas they were previously believed to be continuous and connected, and to bend just at this part towards the south-east.

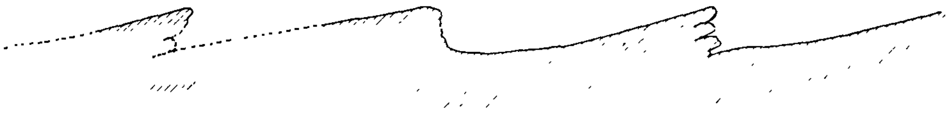

Fig. 78.

The belt of schor was followed by a narrower belt of curious clay elevations, or small regularly formed hillocks of about 4 m. in height, lying at the same level and having generally a steep descent towards the north-west, though with a flat slope towards the south-east (fig. 78). They were coated with a thin layer of glittering snow-white crystallisations of salt, so that when seen from a distance they looked like the ruins of ancient marble palaces. Thus here too, as in the belt of schor, there is an abundance of salt; in fact, the clay must be interpenetrated with salt, for after the superficial layer has been transported by one or more storms, the salt »effloresces» again from the interior of the mass. We did not see any such salt-coated clay-formations amongst the jardangs of the Kuruk-darja and the old Lop-nor, the reason being that the western part of the lake, as well as the river, contained fresh water, whereas the eastern parts of the lake were filled with salt water, just as we find to be the case to-day with the Kara-koschun.

This zone is bordered on the west by another zone which lies a couple of meters lower, and has the appearance of a distinct depression or bed along the middle of the bay already alluded to. The ground here again was pretty hard and strewn with gravel. In all probability therefore this more deeply eroded depression is the channel along which the transient stream of the great latitudinal valley finds its exit, or at all events formerly sought a passage, bringing this gravel down with it.

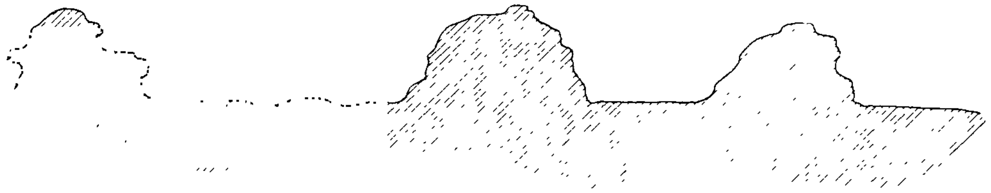

Fig. 79.

The next zone on the west, which appeared to lie a shade higher than the gravelly bottom, was traversed by clay ridges 4 to 6 m. high and 7 to 10 m. broad, drawn out north and south, or rather N. 5° W. and S. 5° E. Fortunately they were pierced at irregular intervals by gaps or passages (fig. 79): had it not been for them, it would have been altogether impossible for us to cross this tract of country transversely with camels. For the clay ridges or jardangs have vertical or steep sides, and stand quite close together, 10 to 40 m. from one another. Sometimes we had to go half a kilometer or a whole kilometer to north or south before finding a gap. On the whole the ground between the jardangs is level, except for small elevations and terraces in the tolerably hard yellow clay, which was deposited in horizontal layers and was, here again, heavily impregnated with salt. This furrowed region too extended as far north and south as we were able to see; though it gradually inclined to south-south-west and north-north-east. In its western half the elevations were somewhat farther apart and the breaches in them were at the same time more numerous. The only agency that can have built up or sculptured this bizarre, yet regularly formed, landscape is the wind. The fact of the axial line of the grooves deviating from the direction of the prevailing wind, as exhibited in other parts of the Desert of Lop, does not necessarily militate against this supposition, for in this region the wind may quite well blow prevalently from the north, owing to the disposition of the adjacent mountains and the gaps between the different ranges, or owing to yet other causes. Nor can it be considered a bold hypothesis, to assume that, as I have already said, these grooves, which are at the most 6 m. deep, have been chiselled by the wind. To anybody who attempts to thread his way through that labyrinth of »cuttings» and corridors between the clay terraces, the effect of the wind's energy appears to be extraordinarily great; but a little reflection will show that there really is nothing so very surprising in it. For if we suppose that this bay of the ancient inland sea still contained water at the time when Lôu-lan was inhabited — i. e., according to the MSS. which I discovered there, in the 3rd century A. D. — and dried up shortly afterwards, the wind has had a period of 1600 years in which to accomplish its sculpturing work in the clay. In other words, the layer of clay which it has had to remove every year has not exceeded 4 mm. This figure varies of course for different parts of the zone in question; for some of the jardangs are only 4 m. high, and even less. The reason why these flat-topped elevations have not been blown away too is no doubt that which we have already discussed when dealing with the region beside the Kuruk-darja, namely the binding properties of the vegetation. At the present time there does not remain, on their summits, the least trace of vegetation, not even withered roots. From this we may infer, that this part of the lake-basin dried up earlier than the portion beside which Lôu-lan stood. It is conceivable that this region never did possess forest like that on the banks of the Kuruk-darja; but there must certainly have been kamisch, although there is not now a trace of it to be seen. The long clay ridges make it however extremely likely that tamarisks at any rate existed there, for nothing but the presence of binding roots can explain the possibility of certain portions having survived. All traces of former vegetation are now entirely obliterated, and since its disappearance the ridges themselves have been exposed to the destructive agency of wind erosion, although at the same time this agency is operative with greater energy in the grooves. The amount of erosion assumed above, namely 6 m. in 1600 years, is therefore far from exact; for not only is it probable that this part of the ancient lake was laid dry long before the 3rd century A. D., but the altitude of the ridges themselves would be higher than they are, had their summits coincided with its bottom-level.

After crossing over all these successive belts of the ancient watery region, we traversed some flat, gravelly hills, between which the dry torrents generally made their way south. In two or three places amongst these hills there were self-contained basins in miniature, into which, as the level, cracked clay surface and two or three small living tamarisks proved, water does sometimes gather, being held up there as in a saucer.

All day on the 18th February there was a storm from the north-north-east, which drove before it along the ground vast quantities of hard material, coarse sand, and small pebbles. This direction of the wind corresponds at all events with the position of the western clay ridges. At first our track led across a peculiar country, consisting of small, narrow, elongated hills, composed chiefly of gravel, though also of hard rock; their sides were often pretty steep, and they were separated from one another by depressions, in which it was the rarest thing possible to find eroded watercourses or any signs of running water. These depressions, in the bottom of which sand had once accumulated, were in places disposed parallel with one another, and like the ridges in general parallel with the clay terraces or *jardangs*. Yet this is not true of them all, for those in the east extended north and south, whereas those in the west ran north-north-west to south-south-east. The absence of eroded watercourses and the impossibility of determining in which direction these hollows inclined made it tempting to ascribe their origin also to the erosive agency of the wind; which has of course been operative here an inconceivably longer time than in the clay desert farther to the east. The real cause of this relief is however that the rock (green schist) dips due east at an angle of 35°. If the wind does play any part in chiselling out these long depressions in the rocks, it is certainly a subordinate part. In the matter of erosion, the wind takes here the place of flowing water. The country is flat, the differences of elevation are inconsiderable, all superficial forms are rounded by the wind, which carries on its levelling work everywhere alike, whereas in countries possessing rainfall the operation of running water is confined to the deepest groovings of the surface, which it goes on deepening ever more and more, thus accentuating the differences of elevation. Yet water is so rare here that it has not succeeded in impressing the stamp of its agency upon the relief features of the region.

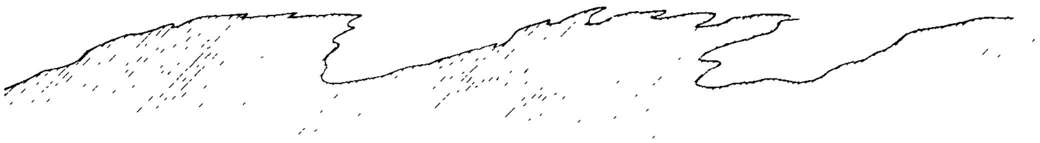

Fig. 80.

On the other side of these parallel ridges the country was again open, although we found a couple of quite insignificant hills in our path. The ground was hard, and covered with fine gravel. The range which had looked so imposing when seen from a distance now cropped up on our right, but it turned out to be merely a low crest. Beyond it to the west-north-west was another yet higher range. One is sometimes deceived in these regions: in consequence of the dust-laden atmosphere a range close at hand appears to be a long way off, and proportionally high, and one is then amazed to find oneself at its foot so soon. Towards the end of the day's march, the ground inclined generally towards the south, as we perceived from some eroded watercourses, here more distinctly marked, which came down from the mountain-range on the north. Some of the outliers of that range, in the immediate vicinity of Camp No. CLI, consisted of a hard, compact variety of rock, arranged in layers of varying thickness, although their height altogether was not more than 5 m. They proceeded due south, and resembled waves suddenly arrested whilst in motion (fig. 80). Here too the effects of wind erosion were discernible, for the outlines of these outliers were rounded like those of the jardangs. Keeping to the west of them, we followed for a time a deeply grooved trench leading towards the south-west and south. During the entire day's march of 38 km. we did not see a single piece of wood as big as even a match. On the other hand, the tracks of wild-camels were quite numerous, and they were all directed towards the south-west or the west-south-west, though some went towards the north-east. Probably we were now not very far, perhaps only one or two days' journey, from the spring of Otun-bulak, of which we had heard spoken; its name was suggestive of fuel as well as of water.

On the Russian maps, except the map of the General Staff, the whole of this region between the Tschöl-tagh and the Kuruk-tagh is called the Ghaschun-gobi, that is to say the Salt Desert. I have not heard this name used, as I never had anything to do with the Mongols in that part of Asia, but it appears to me to be very appropriate. Such springs as exist, and in most cases their situations are only known to the hunters, do yield salt water; and my own description is enough to prove that the region is a desert. But the significant fact about the Mongolian name is that it is not Ghaschun-ula, but Ghaschun-gobi, and quite rightly too, for its desert character is much more pronounced than its mountainous character. To extend the name Kuruk-tagh, as our maps generally do, all the way to the vicinity of the lake of Chala-tschi (Chara-nor) is incorrect. That name ought to be restricted to the mountain-system which begins at the Kontsche-darja and stretches north of Altmisch-bulak and the bay of the Lop-nor basin in the way I have just described. The chains of this system extend from Altmisch-bulak towards the east-north-east, that is right through the middle of the Ghaschun-gobi and immediately south of the lake of Toli, or rather south of the spot at which, according to the maps, that lake is situated, for I think its real existence extremely doubtful. North of this eastward continuation of the Kuruk-tagh we have the Tschöl-tagh, and south of it the five small parallel spurs *en échelon.* These however ought rather to be reckoned as belonging to the P'e-schan system, and as forming its immediate westward continuation.

The 19th February was the eleventh day since the camels had their last drink of water just north of the spring of Toghrak-kuduk. Throughout the entire stretch of country which we had traversed since then the only supply of water we had come across was the snow-drifts I have mentioned. Hence we may with perfect justice say that travelling across this region is attended with great peril; and it is easy to understand why this part of the country has never been visited by any traveller, indeed it is seldom visited even by the native hunters. The traces of an old road or roads which we hit upon among the mountains north of Toghrak-kuduk soon came to an end. This road, running northwards, had no doubt had Hami for its goal, whereas the one that ran to the south-west had merely formed a link of communication between Hami and Lôu-lan on the shore of Lop-nor. Except for these tracks we did not light upon the faintest indication that human beings had ever set foot in this unspeakably desolate and barren region; which nevertheless, despite its stirility, is a veritable paradise for the wild-camel.

At the beginning of the day's march the tracks of that animal ran towards the north and south, or north-east and south-west, but farther to the west in every possible direction, though perhaps chiefly to the south-west. At the same time they grew more numerous.

To the north of our route extended a bare and desolate range, not very high and of a reddish-brown colour; to the south lay the great Lop Desert with its everlasting jardangs, hillocks, and terraces — a yellowish grey sea shrouded in the dust-haze. On that side there was no longer any mountain-range, not even the smallest elevation, to shut out the view, and the higher ground on which we were travelling did not appear to be more than a score of meters or so above the level of the desert. We crossed over several ravines running towards it. One larger watercourse, in the bottom of which some scrubby plants were growing, ran south-east, and appeared to come from a smaller latitudinal valley between the reddish-brown chain and another chain towards the eastern end of which we were marching. Owing to

Pl. 10.

SCANTY REEDS AT CAMP CLIII (FEB 22ND 1901)

Ljustr A. B Lagrelius & Westpha.

DENSE TAMARISK THICKET AT SAME CAMP

the murkiness of the atmosphere I was unable to make out its orographical structure; possibly the watercourse issued from a larger transverse glen in the same chain, though the alternative just suggested is the more likely. Anyway the fresh chain which we now had immediately on our right had a south-west strike; and the same direction was adhered to by the principal watercourse which ran close under its base, gathering up all the dry brooks that came out of the range as it proceeded. In several of them there were living scrub and tamarisks growing on mounds. We observed the tracks of hares, antelopes, and wild-camels; the presence of the smaller animals suggested that there was a spring not so very far away. In a pretty deep side-ravine we found a mound a good deal higher than usual and crowned with tamarisks; the ground round it was very moist and coated with salt. Here too there was water pretty near to the surface, but it was excessively salt. Near the mouth of the next transverse glen, which was cut down through the slope to the depth of 3 to 4 m., a little salt spring gushed out, and formed an ice-sheet about 12 m. in diameter and 1 dm. thick. This spring, which really saved my caravan from destruction, was evidently one of those that Abdu Rehim had told me about the year before. A conclusive proof that the spring is known to the hunters existed in a small semicircular rampart crowning the hills overlooking it on the left-hand side. It was built of clods of earth, packed one upon the other to the height of ½ m., and evidently had served as a screen for some hunter lying in wait for wild-camels. Just above the spring grows the hard desert plant *tschutschun*, though in the immediate vicinity of the spring itself there is no vegetation except two small tamarisks. The temperature of the water was + 2°.2 C., and its specific gravity 1.021. At the head of this transverse glen, we saw, at a distance of about 6 km., the mountain-chain, which now appeared to be of pretty considerable dimensions. Just above Camp No. CLII there was a large cairn of stones crowning a hill and visible from the spring. Possibly the ancient route between Hami and Lôu-lan may have passed this spring, which is no doubt of great value in winter, when there is ice.

Continuing our journey to the south-west and west on 22nd February, we crossed over a great number of smaller dry torrents, bordered by low elevations. In two or three of them we found pretty large quantities of tamarisk trunks and branches embedded in the dry mud at the bottom. The chain which lay nearest to us on our right ceased to be continuous on the farther side of a larger watercourse, and was thereafter broken into smaller detached groups and knots, which often showed miniature peaks and jagged crests. But it was overtopped by another crest immediately behind it, apparently the highest range we had yet observed. To the south there were no mountain-ridges, only low hills. Of the clay desert we could see nothing, the atmosphere being thick with dust in consequence of the violent wind. Generally the surface was hard and level, and strewn with fine gravel. On a little isolated hill, with steep sides, which we passed on our left, there appeared formerly to have been a cairn of stones, though it is now thrown down. We made Camp No. CLIII in a very shallow, ill-defined dry torrent, running to the south-south-east. On a small area we found here a tangled thicket of living tamarisks, several of them withered, together with a little kamisch. In the deepest part of the bed the surface was moist, but after striking a layer of salt as compact and as hard as a stone we proceeded no farther with our well-digging. A few hundred meters higher up the same valley there appeared to have been a spring, which flowed as recently as only one or two years ago, though since then it has dried up; there was a little vegetation. To the north-north-west we perceived a portion of the higher range in the background.

On 23rd February we traversed a gently undulating region, furrowed by several dry brooks running towards the south-south-east. The ground was hard, and at intervals the *tschikende* scrub was growing on tiny mounds. The nearer broken range on the north still continued to run towards the west; and immediately to the south of it an entirely new range now made its appearance, and along its southern base we had to travel to reach Altmisch-bulak. So far as we were able to see for the dust-laden atmosphere, the space between the two ranges was occupied by a latitudinal valley of no great breadth, but level and open for as far as we could see to the west. From the eastern part of the new range several dry brooks proceeded to the south-east. In one of these we discovered a spring, which yielded water with a specific gravity of 1.015 and formed a pretty big ice-sheet; but there was no vegetation near it.

During the rest of the day's march to Camp No. CLIV we crossed over a series of flat spurs projecting from the range nearest to us on the north, with plainly marked torrents between them. In one of these there was a little oasis of tamarisks and kamisch. We made our camp at another similar oasis, which had also a supply of water, and was bisected by a strip of barren gravelly soil, with small hillocks of greenstone. Between this strip of gravel and the western half of the oasis there was a dry brook, 1½ m. broad and 1 m. deep, in which the saliferous character of the water was manifest (sp. gr., 1.012); the space was however too confined to permit of sheets of ice being formed. This then was the third salt spring of which we had been told the year before; and the statement that the salinity of the springs increased towards the east was therefore correct.

During the course of our march on 24th February the chain nearest to us on the north increased in altitude; but it was uneven, swelling up in places into a serrated crest, with deeper saddles and gaps between. We crossed over two torrents pretty deeply scooped in the ground; one ran towards the south, the other towards the south-east, though lower down they united to form one. Around them the surface was very uncomfortable to march over, consisting as it did of a labyrinth of hillocks, thresholds, and ridges, all of greenstone, and with a predominant dip of 69° S. 10° E. A little south of our route the hard rock came to an end, and the gravel-strewn saj sloped slowly down towards the clay desert, though the latter was no longer visible. On the other side of the two big watercourses the ground was seamed by thousands of tiny dry rivulets, and the gravel was exceptionally abundant. A miniature mountain-ridge, only a few hundred meters long, lies at the foot of the larger range. Except for one relatively high swelling, covered with drift-sand, sand is entirely absent from the range in question. After crossing over a last greenstone elevation, situated not very far from the southern foot of the range, we saw in front of us the oasis of Altmisch-bulak, considerably bigger than the other oasis, mentioned above, that lies to the east of it.

Pl. 11.

*Ljustr. A. B. Lagrelius & Westphal.*

ONE OF THE SMALL OASES AT NORTHERN FOOT OF KURUK-TAGH

By this reconnaissance across the Ghaschun-gobi I succeeded in filling up an important gap between the Kuruk-tagh and the P'e-schan. Just as the parallel chains of the last-mentioned system terminate at the eastern edge of the wedge-shaped jardang depression, so we passed two parallel chains of the Kuruk-tagh, which in a similar way come to an end at the western edge of the same depression. North of these two we perceived yet two others, and, generally speaking, we observed that these ranges increased in altitude from south to north. The one to the extreme north, which was also the highest, though we only saw it from a distance, is no doubt the one which I had assumed to run east-north-east to the country south of the lake of Toli, and which we touched at our northernmost camp on this excursion. On the whole the chains of the Kuruk-tagh, with which I came into contact, have everywhere the same strike as the chains of the P'e-schan — namely, from west-south-west to east-north-east. But at exactly the meridian of Lhasa there is a breach between them, perhaps a fragment of the earth's crust here subsided, and into this breach the former inland lake of the Lop basin thrust a wedge-shaped bay. How far this bay extends towards the north-east I cannot determine, though at the point where we crossed it it was already quite narrow.

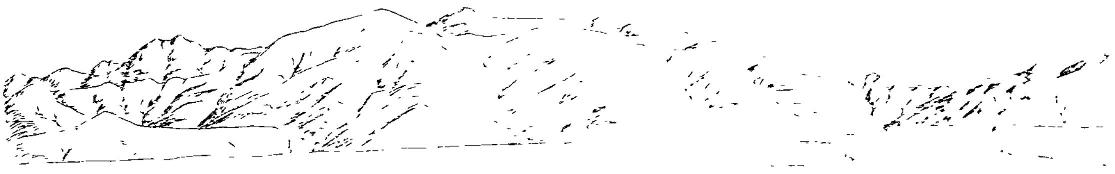

Fig. 81. THE KURUK-TAGH WITH THE ENTRANCE TO THE VALLEY OF SUGET.

As for the general characteristics of these mountain-ranges, my observations are in agreement with those of the travellers quoted above. They are relatively very low, disintegrated, barren, and extremely ill-provided with springs. Sometimes they form hilly ridges, sometimes fantastic craggy crests. As they proceed from west to east, they grow increasingly lower, spread out wider and wider, and are less continuous and less connected. Between the wedge-shaped bay on the west and the meridian of Chala-tschi on the east the southernmost ridges are very insignificant; in fact, they cannot be called mountain-chains at all, they form rather a boundary «rim». As I have just said, the southernmost chain of the Kuruk-tagh is larger in size, and at its southern foot lie Altmisch-bulak and the three unnamed (?) springs. The map of the Russian General Staff is in error in putting Altmisch-bulak to the north of the southernmost chain. As a matter of fact, south of Altmisch-bulak there is nothing more than a threshold of perhaps 10 m. in height, which extends only a few hundred meters east of the spring. From the southern foot of the chain of Altmisch-bulak a flat gravelly scree sinks down excessively slowly to the clay desert. On the general map that accompanies the account of Roborovskij's and Kosloff's journey of 1893—95 there is a narrow strip of sandy desert between this range and the Kuruk-tagh; this is quite erroneous, for in that quarter there is no drift-sand whatever.

# KARA-KOSCHUN.

# CHAPTER IX.

## THE WATERS TO THE NORTH OF THE KARA-KOSCHUN.

Of the long course of the Tarim which we have hitherto followed bit by bit through East Turkestan, there remains now only a very short portion for me to describe. But instead of proceeding to describe straight away the embouchure of the river into the marsh of Kara-koschun I have preferred to record in chronological order the observations I made in its vicinity. This will however in no wise impair the general view, but will on the contrary facilitate the use of the atlas, which it is the object of this explanatory text to accompany as faithfully as possible.

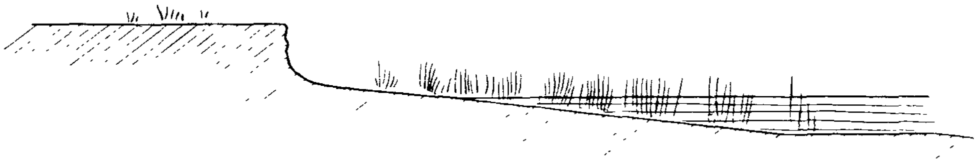

Fig. 82. VERTICAL SECTION OF THE SHORE AT CAMP XXI.

Let us, then, turn to the 2nd April 1900, when, after crossing the Desert of Lop from north-east to south-west, we approached the northern shore of the Kara-koschun, and made our Camp No. XXI. Here we had before us a pretty extensive sheet of water, the basin of Kanat-baghlaghan-köl, and as it was of a dark green colour, I thought it might be of considerable depth, deeper perhaps than the Kara-koschun. The region was completely uninhabited, not a sign to indicate that human beings ever visited that part of the world. But as I was resolved at all costs to take a series of soundings across the lake, we improvised a sort of raft out of the pack-saddles of our camels and *tulums*, or goat-skin bags, for holding water. It is true, there was kötäk of both toghrak and tamarisk in two or three places, but although this appears to be as light as cork, it nevertheless sinks in water; for soft, porous, and cracked though it is, its every pore and crevice is packed full of drift-sand. Although the grey split wood is excellent for burning, it is unsuited for raft-building.

Next morning the wind blew with a velocity of 9.9 m. in the second from the N. 57° E.; and was therefore just right to carry us across the lake. Accordingly we made our way N. 60° E. along the shore. The opposite or south-western shore, where our tent was pitched, was distinctly marked, in consequence of the impact of the waves, which work with the greatest force and reach their greatest height in precisely that direction. The escarpment of the shore is 1 to 1 1/2 m. high, and below it extends a gently sloping abraded terrace, in part overgrown with reeds. The water that washed it was at that time brownish grey and muddy.

At the very first glance it is patent to the simplest understanding that this lake must be a recent creation, and it can only be a very few years since its basin was filled with water. For its kamisch is extremely thin and poor; indeed, except for an occasional small scanty tuft, the shores are perfectly bare and barren. The shore, which consists of the same *schor* that occurs in several parts of the Desert of Lop, is brittle and friable when dry, but when moist forms the softest and most treacherous mud possible. The saliferous *schor* does not however in any way prove a hindrance to the sprouting of the kamisch; but here the water has made its appearance so recently that the kamisch has not had time to spring up. Whenever it accompanies the water, it desseminates itself very quickly. In fact, when I revisited the same spot a year later the kamisch had increased to such an extent that it was difficult to recognise it again.

The southern shore of our lake formed a pretty straight-edged terrace, sharp-cut, and perfectly sterile, and the *jars* and *jardangs* were arranged in two or more »storeys» of different heights. From a hill on the other side of this low clay ridge we observed yet another lake to the south, either connected with the Kara-koschun proper, or else forming a part of it. Along the southern shore there were at intervals patches of kamisch-stubble, surviving from some former overflow period, and presenting the same appearance as the kamisch-stubble in the interior of the Desert of Lop.

On our left we had two small elongated sheets of water; hence we directed our steps to the tongue of land which lay between them and the main lake. In these little lakes there is a sprinkling of tamarisk-mounds; while perfectly barren dunes of a pretty considerable size overlook their north-western shores. And there are dunes again on the tongue of land between the lakes themselves — a significant fact. They tell us that they were standing there already when the water first appeared upon the scene; otherwise the sand of which they are built up would never have been able to transport itself across the sheets of water that stretch to windward of them. On the other hand if no change takes place in the distribution of the water, these dunes will be able to maintain their present position a pretty long time, for the wind is moving them along the tongue of land out towards its extreme tip. Their horns or wings extend parallel to the shore; in other words, the same parallelism which governs all the relief forms throughout the Desert of Lop obtains also on this shore. The lakes extend from N. 60° E. to S. 60° W.; the groovings caused by wind-erosion stretch north-east and south-west; the steep sides of the dunes look towards the south-west; the prevailing winds and the storms come from the north-east: and it is the wind which both models the relief features and controls the dunes.

In places along the shore there is, as I have said, some dead wood; it is certainly old, for it is no longer standing on its own roots. Near to our camp rather large quantities of drift-wood were stacked up on the shore by the waves, though the pieces were all small and hard — another proof that the lake is of recent origin. Owing to causes which we shall investigate lower down, the masses of water have here spread themselves out towards the north. In consequence of this the timber which has recently died, and therefore will float, is set adrift and carried by the waves uniformly towards the south-west. Were the lake old, this drift-wood would have disappeared underneath the dust, the shore-ramparts, and the kamisch. Living tamarisks are pretty numerous on the tongue of land between the lakes; they existed of course before the new lake-basin was formed.

We pulled up at an island, separated from the shore by a narrow sound, and having a little pool in its middle. From that spot we were able to see how the lake divided in the east: for while the main body of the water lay towards the S. 85° E., a large bay stretched north-north-east. I should have investigated the extent and range of distribution of these sheets of water, had it not been that we were short of provisions, as well as reduced generally to a low ebb, and the fact that the season was advanced. In the following year however I made in precisely this same locality the wholly unexpected discovery, that the lake in penetrating up this north-north-east trench at such a rapid rate was in reality travelling bodily towards the north and north-east.

It had taken us 40 minutes to reach the island; from the island it took us 2¼ hours more to drift back to camp, and yet the distance was barely 3 km.! But the lake ran high, and out in the middle its water was not quite clear, nor quite fresh either. It was evident, the wind had driven thither from the east water which had been lying stagnant, and so become salt; for, as I subsequently ascertained, the water of the Kara-koschun grows increasingly salter in proportion to its distance from the mouth of the Tarim. Large masses of water are driven south-west by the long-continued wind; of this we had indeed a direct proof in the fact that during the course of the day the water rose 1½ dm. at our camp; and on the evening of the 4th April its level had risen 33 cm. in the last 48 hours. Indeed the water at camp was so salt that we regretted the empty condition of the goat-skins in which we had brought water with us from Altmisch-bulak, but which had come to an end a couple of days previously.

The lake swarmed with wild-duck; but wild-swans, gulls, and wild-geese were in fewer numbers. South-west of the island the lake was at first shallow; then the depth gradually increased to 2 m.; and after that we obtained soundings of 2.55, 2.0, 1.80, 2.20, 2.35, 3.22, 3.01, 3.61, 3.70, 3.20, 2.15, 3.35, 2.22, 2.62, 2.20, 1.75, 1.50, 1.30, 1.02, 0.90 m., and then the lake once more shallowed. Thus the maximum depth in this new basin was 3.70 m.; consequently it cannot compare in this respect with the Kara-koschun. At the same time, there may be greater depths in other parts of the lake, though the want of a boat prevented us from pursuing our soundings farther.

The storm continued all the following day, and the waves broke upon the shore with such violence that our tent was quite wet with their spray. The reflections on the sky showed that the lake extended towards the east-north-east, its colour in that direction being a muddy steel-grey, though at both sides of that it was a dark fiery yellow, pointing to the presence of drift-sand and dust below it.

On the 5th April the atmosphere was heavily charged with dust, so that our view was to a considerable extent restricted. We followed the lake south-west as far as it extended. Except for the scanty reeds at the water's edge, the shore was perfectly bare of vegetation. On the right we had an almost unbroken belt of dunes, at only one or two hundred meters' distance from the water. It was here we came upon the first signs of human beings, namely two men, probably hunters. Cow-droppings showed that live-stock had been grazing there recently. Of wild animals we noticed wild-duck, wild-geese, swans, gulls, terns, and crows, hares, foxes, roe-deer; and there were vast quantities of wild-boar tracks, as well as of a species of *Felidæ*, probably the wild-cat, which the natives call *molun*. And here too there were enormous quantities of mollusc shells, of the same kind as those we observed in the old Lop-nor, scattered over the ground down to the water's edge; indeed they were under the water, but there are no molluscs living in it there. The same thing applies to them as to the few dead and withered poplar-trees which still remained standing on their own roots in a few places along the shores. It may sound paradoxical to talk of trees and molluscs being dead beside water. Of this there exists only one possible explanation, but that is as clear as the noonday. It is this: both trees and molluscs died during an intermediate arid period, and the remains which we now found along the shores were much older than the existing lake; for this last is far from being permanent, but changes, even as the winds and the dunes do in this ever-changing region.

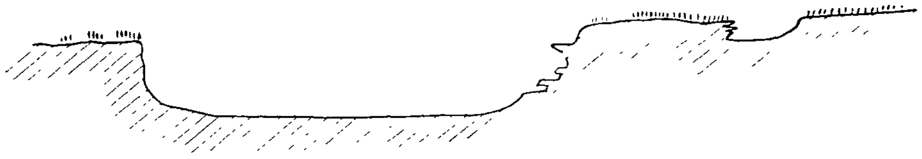

Fig. 83. OLD BED OF THE TARIM.

After coming to the termination of our lake, which ended in a long narrow bay, and after we had seen no water for a good long time, we proceeded towards the south-west, travelling along a distinctly marked, open »passage« between two dune-chains, built up of individual dunes of regular and beautiful formation, semi-crescentic in shape, and standing each tolerably detached from the others, and with their steep sides as usual turned towards the south-west. The open groove in the middle was part of the ancient lake-bottom, still clothed in places with rotting kamisch-stubble, a survival of the last preceding period of watering. Immediately south of that we crossed over an old river-bed of the same dimensions as the lower part of the existing Tarim, namely 45 m. broad, and 6 to 7 m. deep, most distinctly outlined and exceptionally well preserved (fig. 83), with quantities of kamisch-stubble still standing on its banks. There cannot be any doubt that the Tarim once flowed along this channel; for what other river could have scooped it out so deeply? I have already discovered, that the Tarim formerly turned off to the east at Schirge-tschapghan, flowing through the arm which is now called the Tokus-tarim. The river-bed I have just mentioned — another loop of which we crossed shortly afterwards, with three slender poplars that died young still standing on its banks — this is in all probability the eastward continuation of the Tokus-tarim. The Tarim flowed here sufficiently long to give the forest an opportunity of springing up, though to a limited extent only, on its banks. But before the trees were able to grow to maturity, the river took yet another step towards the south past Kara-buran and Abdal.

Apart from this, we were now surrounded on every side by desert, and except for the wild-duck occasionally circling overhead, there was nothing to indicate the presence of vast sheets of water only a couple of kilometers distant. Here too we observed the same sort of incrustation, namely cylinders of sand, cemented by carbonate of lime round the stalks of the kamisch and other parts of other plants, such as are so common in the interior of the Desert of Lop. In certain places the lakes would appear to have been in existence quite recently, perhaps only a few years ago, though it is uncertain whether they were offshoots of the Kara-koschun, or, what is more likely to have been the case, marshes to which the Tokus-tarim sometimes made its way. Anyhow, their shore-lines show that they cannot be old. Here again there are low ridges, one or two feet high, separated from one another by gullies eroded by the wind, and running towards the south-west; but they presented no obstacle to our march, for we were travelling in the same direction. Upon reaching the shore of a new lake bay or tentacle — owing to the hazy atmosphere, we were unable to ascertain whether it was connected with the preceding arm or not — we discovered five slender dead toghraks standing there; but the water itself was so salt that we could only have drunk it at the utmost pinch of necessity. Next we skirted the northern shore of a third lake, which, like the other two, was also drawn out towards the south-west; but, on the other hand, it possessed a greater abundance of kamisch than they do, in fact in places the water was completely concealed by it. On the right we still continued to be accompanied by dunes and the mounds of dead tamarisks.

After proceeding a little farther, our advance appeared to be barred by a watercourse, which wound about in the most extraordinary manner, and sent out ramifications in every possible direction. But we managed to get across it, and then across yet another like it farther on. These eventually turned out to be the two bifurcating arms of a channel with running water, which it poured into lakes that were in some way or other connected with the Kara-koschun. The channel in question winds through a perfect desert, hidden sometimes behind dunes, from which it again emerges, to creep along their foot, wearing them away unceasingly and removing the obstacles that lie in its path. The water would have been drinkable at a pinch, though it had a rank, disagreeable flavour; nor is this to be wondered at, for it cannot be very long since it first made its way thither, and since it arrived it must have absorbed a good deal of the soluble salts of the desert soil. In the first branch there was a not inconsiderable current — 0.42, 043, and 0.50 m. in the second, though this was at the narrowest part, where it was only 9.40 m. broad. The maximum depth there was 0.83 m., and the mean depth 0.40 m., while the volume amounted to 1.88 cub. m. in the second. The second branch had about the same dimensions, and the entire volume amounted to 3.5 cub.m. The water was pretty clear, and had a temperature of only 11°.4 C. The bottom was in general so soft, that had anyone attempted to cross over he would have run great risk of perishing in the ooze; but where it cut its way through the sand-dunes, and its bottom was consequently strewn with sand, it was hard — hard enough in fact to support the camels with ease. Two circumstances showed at once that this stream could not be very old. For one thing, its banks were perfectly barren; not a single living tamarisk, not a single kamisch-stalk could we discover; it was an absolute desert of drift-sand that the water had cut its way through. In the second place we actually observed the current in two places preparing to spread out at the side; it had already in each case entered a little depression, and was just on the point of pouring itself down a tiny cascade, and so spreading out wider. In other words, the water was extending and literally gaining ground at the expense of the desert.

This flowing water cannot very well have issued from any other quarter except Schirge-tschapghan, or rather the Karaunelik-köl, Tokus-tarim, and Jangi-jer. On 16th April we found its volume to be 9.41 cub.m.; on the 5th April previous it was, as I have already stated, 3.5 cub.m. This last stream may indeed be regarded as the extreme tentacle of the eastern system — the remotest terminal, in fact, of the Kontsche-darja. Like the Tarim, it enters the Kara-koschun by a double mouth, but this lies considerably farther to the east and north than the embouchure of the main stream. In a word, we find here a first step in the return of both the moving and the stagnant water towards the north. Other broad sheets of water extended south of this mouth, and by reason of the sterility of their shores they bore the stamp of newness. This also is true of a moderately large lake to the north-west, from which the channel I have been speaking of appeared last to issue. In that quarter too the country was perfectly barren.

After that we travelled a considerable distance without seeing any water, and the clay desert was ribbed with low parallel ridges running in the usual direction, until we at length came to a narrow canal-arm, which, issuing from a lake in the east, ran westwards and filled a small depression. To the south of this last there was yet another lake, abounding not only in kamisch, but also in wild-duck.

On the 6th April we marched a long way south without seeing either water to the east or high sand to the west. But, although we observed neither living vegetation nor wild animals, there was an abundance of old kamisch. In several places we passed dry watercourses, but it was difficult to determine whether they were arms of an older delta or only ramifications and emissaries from the lake. Owing to their number the latter would appear to be their real origin. In every case their banks were clothed with reeds. One of these watercourses was clearly caused by a river, for it was 20 m. broad and 5 to 6 m. deep, and its north-western bank presented an almost vertical face. In fact, these depressions were very often sharply outlined in this way; and it is often difficult to make out whether they owe their existence to water or to wind. It is only those which are accompanied by traces of vegetation that suggest the character of a river-bed. Sometimes, as I ascertained later, a groove may have been scooped out in the first instance by the wind during a dry period, and subsequently become filled by the water the next time it returned to that quarter.

The mounds of dead tamarisks were general. There were no dunes; but when the north-east wind blows, it sweeps a good deal of drift-sand before it. At length we came to a vast marsh of the Kara-koschun; in fact, it was the main body of that lake, and stretched north-east and south-west as far as we could see, plentifully beset with kamisch, waving in the breeze, and with open reaches of water nowhere except along its shores. Here there were abundant signs of human beings, and of live-stock. During that day's march we observed no toghraks, either old or new; we were too far from the old arm of the Tokus-tarim.

Here then, whilst journeying along the north-west shore of the Kara-koschun, we doubled one »polyp-like» extension of the lake after the other, and one marsh after the other, all stretching to the south-west, in accordance with the parallelism which obtains throughout the whole of the Desert of Lop. That denticulated or serrated outline is quite natural, being a result of the relief as fashioned by the wind; the polyp-like arms of the lake are therefore bound to extend towards the south-west. As a matter of fact, I found that this side of the lake presents a totally different outline from that which has crept into our maps since Prschevalskij's journey, although their delineation is not based upon direct observations. Besides this, the Kara-koschun has in many respects changed since Prschevalskij's time.

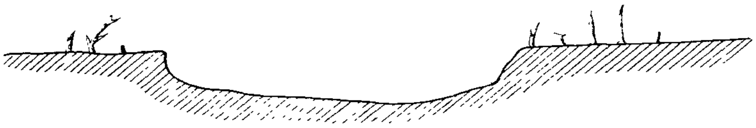

Fig. 84. OLD BED OF THE TARIM NORTH OF KARA-KOSCHUN.

We followed, then, the last-mentioned division of the lake towards the south-west, having on our left large fields of kamisch and on our right a labyrinth of countless tamarisk-mounds, the bushes being some of them living, some dead, together with kamisch and small dunes. As we afterwards ascertained, this marsh is directly connected with the Kum-tschapghan, it being possible to paddle between the two without a break. There can be no doubt that in recent times the Kara-koschun has expanded towards the north-west, an inference warranted also by the number of canals which leave the Tarim between Jurt-tschapghan and Kum-tschapghan, and by the presence of two or three pretty high dunes which rise above the thick kamisch in the middle of the marsh. The dunes are older than the marsh; had the water not come there quite recently, they would have been levelled down and destroyed. Wild-boar, hares, and hedgehogs were common in that locality.

Then we crossed over a newly formed arm, without any current and with perfectly fresh water, and having isolated, not connected, dunes, 4 to 5 m. high, on its right shore. After that a fresh arm of the lake forced us to make a detour to the north, north-east, west, and south-west, and then we encamped, for it seemed to be a waste of time to try to find our way through these marshes with camels when we had no guide. By the evening we were able to procure guides from the neighbouring Kum-tschapghan. These men told me, that the Kara-koschun was then quite as high as it had been at the autumn high-water season. They seldom remembered a winter so cold and snowy as the last had been. The snow was, they stated, 2 span (about 44 cm.) deep on the ice; and it was to this circumstance that they ascribed the great mortality amongst the fish that spring, and the poor quality of those that were left. The lakes and marshes were said to be everywhere full of dead fish floating on the surface.

At the present time, in the region where the Tarim terminates, there exist only three inhabited places — (1) Kum-tschapghan, with 57 settled inhabitants, besides 7 shepherds, 35 people engaged in agriculture at Tscharklik, and 23 who cultivate the ground and breed live-stock at Mijan (also called Saj, though not Muran), making a total of 122 souls in all; (2) Tusun-tschapghan, with 32 settled inhabitants, in addition to 28 agriculturists at Mijan and 13 at Tscharklik, but no shepherds — in all, 73 souls; (3) Jurt-tschapghan, where there are in all 84 people, some of whom dwell at Tscharklik, but the 84 people belong to only 4 ujlik. They used formerly to live at Abdal, but moved to Jurt-tschapghan after my first visit to the place in 1896. Hence, strictly speaking, Abdal no longer exists: the old village remains of course, but its former inhabitants now live at Jurt-tschapghan.

On 7th April there was a fresh wind blowing with a velocity of 14 m. in the second. The drift-sand clung like a thick veil to the surface of the ground, and carried along with it twigs and sticks of the withered vegetation. Thus an astounding transportation of material was actually taking place under our very eyes. A single day's ride such as that is sufficient to give one some idea of the enormous quantities of material that are moved from one place to another by a solitary storm. Everything strains towards the south-west: the dunes descend steeply in that direction, and in the same direction too point their horns. On the south-west side of every mound there exists a rudimentary dune; and it is towards the south-west also that the gullies run which are eroded by the wind. Thither too the storms carry the drift-sand. It may be laid down as a general rule for the Desert of Lop, that the sand increases progressively in height towards the west. In the north-east part of the desert there is no sand at all; whereas in the south-west, for example on the north bank of the Tokus-tarim, there are high dunes. Taking the Kara-koschun as a whole, the distribution of the sand along its shores is as follows. On the east (i. e. north-east) side, which no traveller has yet visited, there are probably no dunes at all, or in any case they are insignificant. *If* dunes *do* exist beside the north-east prolongation of the lake, they must of necessity help to fill up the depression by moving out into it. *If* dunes *do not* exist there, the same result is brought about in an even greater degree by the drift-sand and dust which are blown directly into the lake. The solid material which is thus dropped into it remains there immovably, whereas that which is deposited on each side of it (north-west and south-east), that is to say on dry ground, is caught up by the next storm, and so transported farther. One moment's reflection is sufficient to make clear the consequences of this difference between the dry ground and the wet. Suppose that, on the accompanying cut (fig. 85), the dark rectangle 1 *a* represents the surface of the Kara-koschun, and the light-coloured rectangle 1 represents a region parallel to it north-west of the lake, and having the same area as the lake. Further, let us suppose that the layer of the atmosphere immediately above both areas is at a given moment loaded with drift-sand and dust, carried thither by the prevailing wind, the direction of which is indicated by the arrows. Lastly, if we suppose that the storm, which has just driven the solid material up into the air, ceases, then the material which it has lifted up will be deposited evenly and uniformly over both surfaces 1 and 1 *a*. When the next storm comes, a great part of the material which settled upon surface 1 is again caught up, but that which fell upon the area 1 *a* has meanwhile sunk to the bottom, and is thus inaccessible. During the following storms the solid material is transported successively from 1 to 2, 3, 4, 5, etc. After five storms, or rather five fractional portions of the same storm,* the dust and sand, which fall after the first of these upon the area 1, will come to rest finally upon the area 5. After the second storm unit (i. e. that part of a storm which is represented by the length of the rectangles in question, and which for the sake of brevity I have designated »storm») a fresh layer of sand and dust, brought from the north-east, is spread out over both areas 1 and 1*a*; the former layer then lies upon 2, while upon 2*a* there is practically no layer of similar matter, for the wind section which blows across the lake emerges on its leeward side relatively clear, or at all events it has got rid of the heavier material, and has discharged all the drift-sand it carried with it.

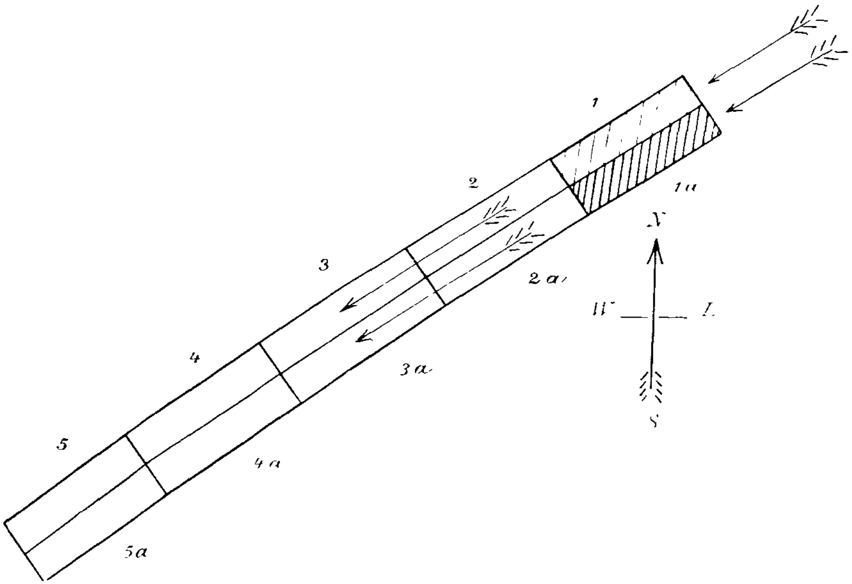

Fig. 85. EFFECT OF THE DRIFT-SAND UPON THE KARA-KOSCHUN.

Farther towards the south-west, say on 5*a*, the balance may be considered to be practically restored again. That is to say, while the solid matter from 1 continues to be shifted onwards stage by stage, transported farther and farther towards the south-west by each fresh storm, the matter which each successive storm drops upon 1*a* remains there, staying where it fell. So that after five storms the layer over 1*a* is five times as thick as the layer which fell originally upon 1. From this train of reasoning it is very evident, that the depression 1*a*, which is now filled with water, must eventually be entirely filled up with solid matter, and that the accomplishment of this result is merely a question of time. In addition to this, there are yet other agencies which accelerate the levelling up of the depression; these I shall advert to lower down.

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* A wind like that which blew at 1 p.m. on 7th April travels 14 m. in the second, 840 m. in the minute, 50 km in the hour, and 1210 km. in the 24 hours; that is in this last period it covers a distance equal to that between Kum-tschapghan and Kaschgar. But where the usual Lop storms come from, and how far they go, I cannot determine. In the Lop region at all events they appear to attain their greatest intensity and constancy in the relatively narrow »gateway» between the Kuruk-tagh and the Astin-tagh — the »gateway» that is which connects East Turkestan with the deserts of Eastern Asia.

Returning to fig. 85 — on that part of the western shore of Kara-koschun by which we travelled, that is along the dotted line, we found little or no sand. Dunes have been unable to form there, because that shore is screened from the prevailing wind, which arrives there without any load of sand. On the other hand there is nothing to prevent the formation of dunes along the eastern part of the northern shore; and, as I have stated, we did observe dunes there on the tongue of land between the main lake and the little lakes at the side on 3rd April. There the dunes travel parallel with the lake-shore in the direction of the prevailing wind; but the dotted area remains practically free from sand. The sand which exists there *now* will in course of time disappear, provided that the present circumstances persist sufficiently long in the future, that is unless it becomes in the meantime bound together by vegetation and collects into mounds. Along the whole western part of the southern shore of Kara-koschun there are no dunes; nor can any originate there, for that shore is sheltered throughout.

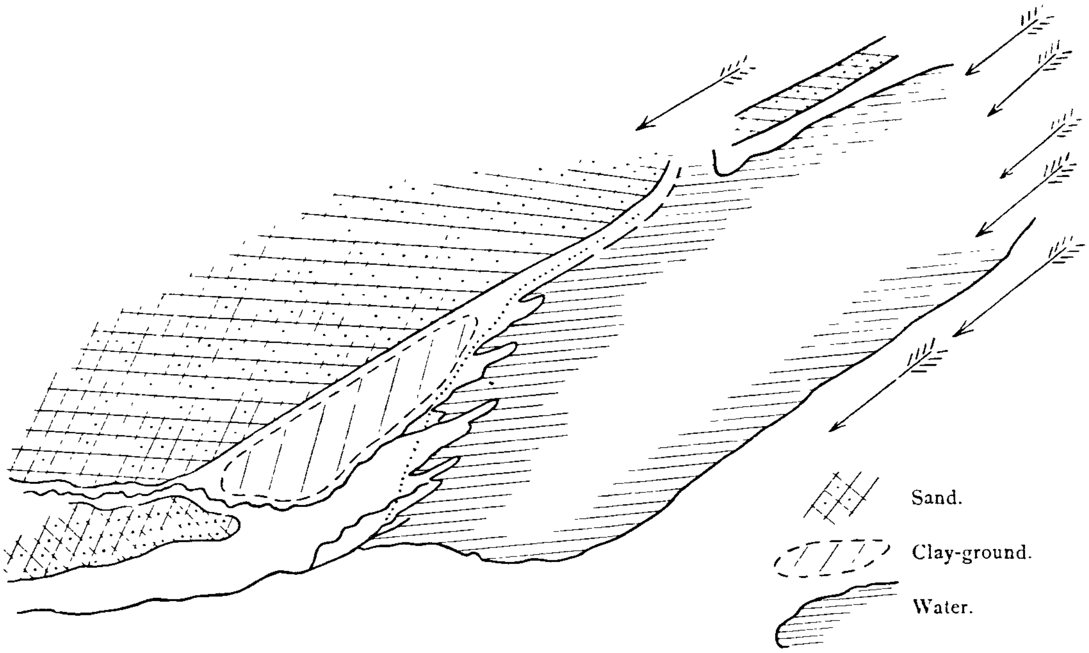

Fig. 86. SANDFIELDS NORTH OF KARA-KOSCHUN.

After that we threaded our way east-south-east through a vast number of small lakes. The river on our right was concealed by the rampart of mounds which help to raise its surface above the level of the adjacent country. At length we saw uplifted ahead of us the detached dunes, bound by vegetation, of Kum-tschapghan. Here is the *saratlik* or »burial-place» of the village, with a fence round the graves — poles with yaks' tails (*tugh*) and fragments of cloth of a peculiar tridentine shape — a custom which put me forcibly in mind of the habits of the Mongols, the only difference being that the latter on their cloth streamers inscribe script signs (prayer formulas).

# CHAPTER X.

## NORTH AND SOUTH WATERWAYS OF THE KARA-KOSCHUN.

The neighbourhood of the river's mouth had not altered in outward appearance since 1896, and the huts occupied the same positions and were arranged in the same way as in that year. The natives were unanimous in saying, that on the whole the river had greatly diminished in volume during the four years, that the sheets of open water in the lakes had become smaller and fewer, as well as shallower, and that the kamish had grown thicker, and the fishing had deteriorated. The Abdal lakes were still in existence. The huts at the village of Örtäng, which existed at the time of Prschevalskij's visit (he writes the word erroneously Ujtun), and those of Kara-koschun (Prschevalskij has Kara-kurtschin, which is incorrect), were burnt down once when the people were burning the old reeds in order to promote fresh growth. Nevertheless both names still survive. But when the natives say, that they obtain timber for their canoes from Kara-köl, they mean the district higher up the river, especially that beside the eastern waterway. Formerly they were able to use for this purpose toghraks from Mijan; but all the suitable trees there having been cut down, those which now remain are too small. In the district of Tikenlik the people get material for canoe-making from the woods of the Kontsche-darja, and the canoes made there are said to be sold to the people lower down the river.

In the evening it began to rain, at first lightly, but by 10 p. m. it was coming down thick and fast, and so continued most of the night, though with several intermissions, until 9 o'clock the next morning. The sky was heavily clouded all the 8th, but it was only in the afternoon that it let drop an occasional shower, and at half-past eight the clouds disappeared altogether. After that the atmosphere was perfectly clear and pure, for the rain had cleansed it from every particle of dust. A sky of such serenity is a rarity in that country; but it did not last long, for fresh dust-clouds were soon imported from the east and north-east. I was told, that as late as the 8th April sheets of ice still remained on the lakes in places sheltered by the thickest patches of reeds. I did not see any myself on the boatingtrips which we took, but the information is not improbably true.

With a couple of canoes, and men who knew the country to paddle them, I now penetrated eastwards from the northern river-arm, the Kum-tschapghan, my object being to ascertain whether the marsh had undergone any noteworthy alteration since I saw it in 1896. After spinning down the river-arm proper on the rapid current, we plunged into the tschapghans, or narrow channels, which are kept open through the reeds for the fishing. Leaving on our right a tschapghan that connects with the village of Tusun-tschapghan, we paddled across the Tusun-tschapghan-köl, which extends from south-west to north-east, though the next basin, the Usun-köl, stretches east and west and has a maximum depth of 2.20 m. On the other side of Bel-tschapghan, 3.12 m. deep, we once more emerged upon an active current (0.56 m. velocity in the second), which however, dividing three times in succession, in that way spreads itself out over the marsh. A great number of nets were let down in its entrance-channels. Proceeding, we passed on the right the spot where the former village of Örtäng stood. Then came a lofty tamarisk-mound, crowned with a nodding plume of branches, projecting above the reeds and surrounded on all sides by water, and then on both sides of our route innumerable others of a similar character. What now is the cause of their being thus situated in the midst of the watery wilderness of the Kara-koschun, and how is it that the action of the water round their bases has not long ago destroyed them? One thing is *a priori* perfectly certain, namely that they are older than the lake; for tamarisk-mounds never arise in a lake or marsh, nor do tamarisks ever strike root in such situations. On the contrary, any that happen to be growing in a hollow basin begin to die when the waters come, as I had numberless opportunities of observing. The mounds persist of course somewhat longer, especially those which do not come directly into contact with the flowing water. In the long run however they are bound to go too. As soon as the tamarisk-bush dies, the resisting power of the mound on which it grew is at an end, and the skeleton of the binding roots begins to rot and wither up. After that the mound, like a ruin, becomes the prey of the wind, and of its transporting and levelling activities. In view, then, of the perishable nature of both the organic and the inorganic material, we may with a fair amount of confidence say, that it is not very long since the water came and encircled these mounds, and that this lacustrine region, at any rate in so far as this particular part of it is concerned, is a new creation, in any case not more than a few hundred years old. Generalising from this law, which does not admit of contradiction, we may venture to affirm, that those parts of the Kara-koschun in which tamarisk-mounds exist are of comparatively recent origin; and this applies to the greater portion of its area.

At Scharkurama (= »cataracts», »waterfall») our stream turned to the north-north-east, with a pretty lively current. Then, entering the Numet-tschapghan, we travelled for a while towards the north-west. Here on our left there was firm ground, with tamarisk-mounds, and to the south-west we perceived other expanses of open water, probably independent sheets with brackish water. For a short distance indeed we had firm ground on both sides of us. In other words, the Numet-tschapghan* there cut through a neck, forming a shallow, winding canal. The water is said to have come thither two years ago; thus the Kara-koschun is, we see, expanding towards the north. In the next stage the depth did not exceed $1^1/_2$ to 2 dm. Every now and again we observed side-basins, the entrances to which were stopped up with dams (*eschik*) of tamarisk-branches and kamisch, to keep the fish in the canals. Extensive areas were covered with a very thin layer of water, which manifestly had come there quite recently. In one place the velocity amounted to 1.49 m. in the second, the water boiling as it raced on past the nodding, bending reed-stalks. On the whole, firm ground is general thereabouts and the reeds quite thin. Kum-köl is said to have been formed two years ago, and it is into it that the impetuous little stream pours itself. There is but little kamisch in the lake, but it is noteworthy that what there is should have been able to spread as it has done in such a short period as two years. On our left, that is on the north, we could see the summits of the sand-dunes; hence the name of the lake. New lakes have new names. The greater number of the basins I was then passing through and near did not exist in 1896, but had come into existence since that date; whereas the route I pursued in 1896 is now overgrown with reeds. When the old lakes disappear, their names vanish along with them, and are no doubt forgotten by the second generation, for they are then names possessing on the whole no importance. Upon reaching the northern shore of Kum-köl we were not very far from our line of march of 5th April. Jangi-köl, the New Lake, is a name that speaks for itself: it was 1.12 m. deep. I

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* The proper meaning of *tschapghan* is »dug«; consequently Numet-tschapghan is equivalent to »dug by Numet«. The verb is *tschapmak*, »to dig«. Used as a substantive, *tschapghan* = »canal».

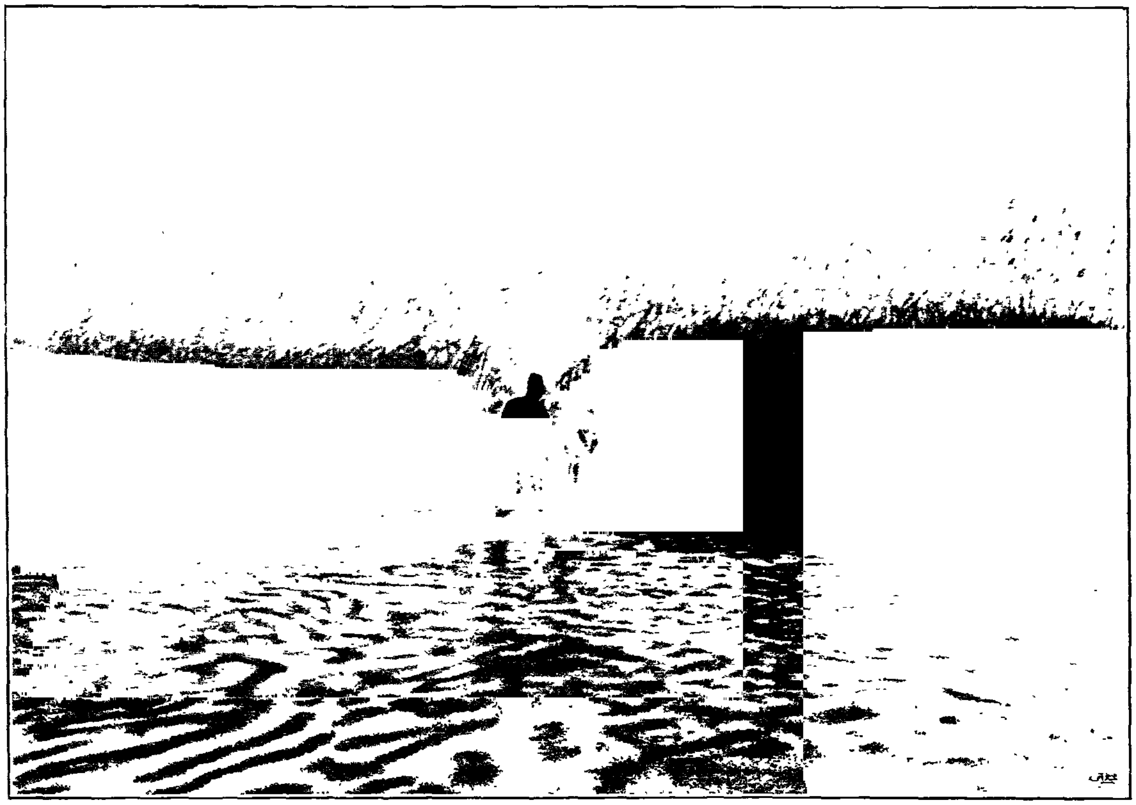

Fig. 87. A SMALL OPEN »KOL» IN THE KAMISCH OF THE WESTERN KARA-KOSCHUN.

always made these soundings in the parts which appeared to be the deepest, or which my canoe-men told me were the deepest. Accordingly, it may be taken, that the other parts of these lakes were shallower than the several respective soundings which I quote. On the north shore of the Ghol-köl there were innumerable mounds.

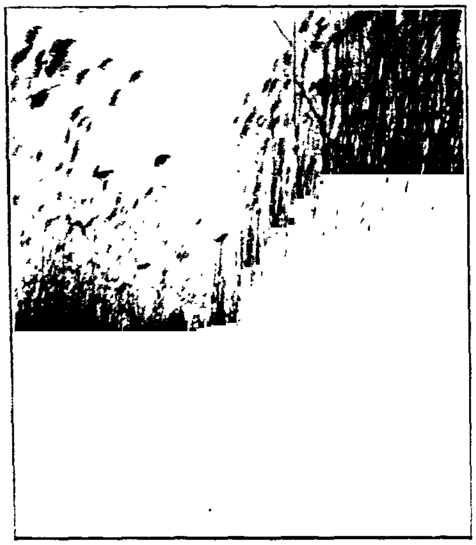
Fig. 88. TSCHAPGHAN IN THE KARA-KOSCHUN.

Dead fish were seen floating on the water or lying upside down on the bottom of the lakes, their bodies shining white through the pure, limpid water; and the farther east we advanced the more numerous they became, often as many as a score or more together in one small area. Judging from the vast numbers we saw, I should say there were hundreds of thousands scattered over the whole of the Kara-koschun. The natives believed, it was the quantity of snow, together with the thick ice, which had killed them. In a lake so shallow as this the explanation is not unreasonable, for over large areas the marsh must have been frozen to the bottom, and certainly those portions would be cut off and isolated which lay behind the shallow thresholds. Higher up in the Kara-koschun, where the current was still lively, the mortality is said not to have been so great. The fish however were in worse condition than the natives ever before remembered them to have been. Very often there was a rank, unpleasant smell of putrid fish on the lake. Large flocks of crows were circling over the northern shore, no doubt attracted by the dead fish. It was as though a large part of the fish in the Kara-koschun had been smitten with some epidemic; anyway, their remains would help to fill up the lake. Generation after generation of them are spawned and die, and their skeletons and other remains settle down into the mud at the bottom. We also saw a large number of dead wild-duck. They were said to be birds which usually spend the winter at Kara-koschun, keeping to the parts in which the currents prevent the ice from forming, and where there is consequently open water all the year round. But that year even these places had been frozen over, and the wild-duck, being unable to get at their food in the mud at the bottom of the marsh, had perished of hunger and the intense cold.

In places where the reeds were thick we noticed several narrow passages, or tunnels, leading through them. At first we took these to be ordinary tschapghans; but we were soon informed differently. They were made by the wild-boar forcing their way through the reeds on the ice, and thus breaking them down to the level of the water. As for the tiger, he had not been seen on the shores of the Kara-koschun during the last two years. I was told a wonderful story about the tiger, a story which sounds quite fabulous, and yet the natives asserted that it is a fact. They said that when the she-tiger throws young, she always avoids localities in which there are ants, for the ants attack the young tigers in thousands, and kill them, and the natives assigned this as the cause of the tiger's not having shown himself there during the two preceding years, for the ants had been more numerous than usual. I should not have mentioned this story, had it come from any other source except these simple Lop-men, whose imagination is so restricted, that they would never invent such a thing unless there were some sort of warrant for it in actual facts.

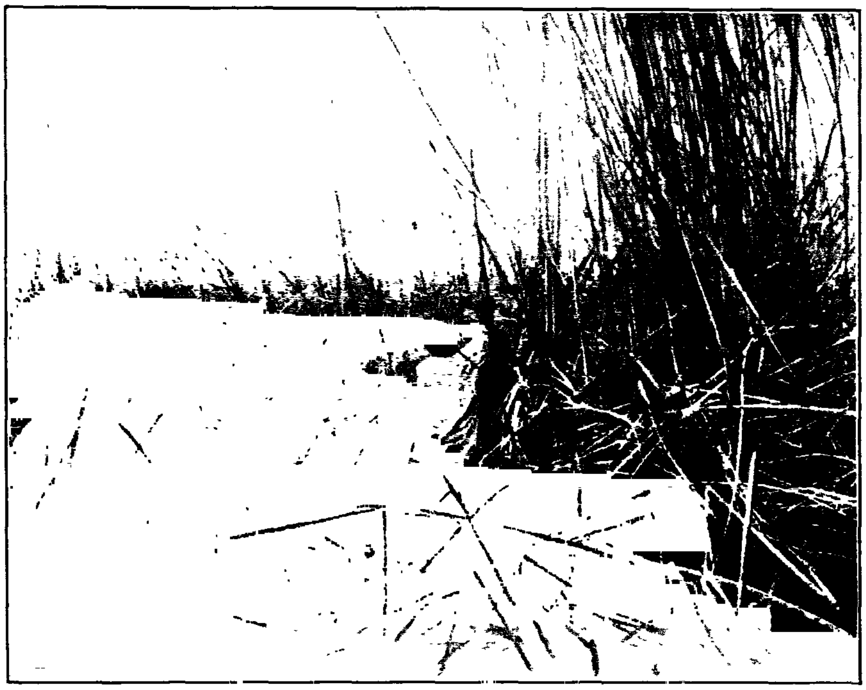

Fig. 89. A "TSCHAPGHAN" IN THE SUJI-SARIK-KOL.

Otak-köl is bounded on the north by firm ground, with tamarisk-mounds; its greatest depth was 1.90 m. On the shore of the lake-basin of Tojaghun we discovered three *aghils* (sheep-pens), containing in all 100 sheep, guarded by some shepherds. Strange to say, we had seen nothing of them when marching past that way. The two inhabited places in the Kara-koschun district, namely Kum-tschapghan and Tusun-tschapghan, are said to own altogether 2300 sheep. Nias Baki Bek alone owns 600, and his elder brother 900; but as a rule each man possesses 30 to 50. The animals are grazed partly in that neighbourhood, partly at Mijan. Sheep were kept in Prschevalskij's time also, though not to the same extent. The natives are said to set a greater value upon fish than upon sheep. If they lose a sheep, they take it quite calmly; but if a fish slips out of a net, they are greatly annoyed.

Beside the lakes of Tojaghun and Usun-köl there exist in all three toghraks, about ten years old, and these were the only ones the natives were aware of in that region. These three trees have evidently come from the Tarim and have been transported by the current *via* Tschigelik-uj. They prove that there is nothing to prevent poplars from spreading and thriving there, and that it is not the fault of the soil that toghrak forest does not clothe the banks of the Kara-koschun. If only the lake should remain where it is a sufficient length of time, forest will beyond doubt establish itself on its shores. The only reason there is not any as yet is that it has not had time to get rooted; in other words, it is because the lake is an altogether too recent creation. On the shore of the Tojaghun there also lay three pretty big poplar trunks, belonging to old dead toghraks. They had been brought by means of oxen from a place half a day's journey to the north, and had been intended as the corner-posts of a hut it was proposed to build. In connection with them, Nias Baki Bek, the chief of Kum-tschapghan, himself a man of 64 years of age, told me that his father, who died twelve years before, aged 110 (?), had, when a young man, seen poplars growing in the place from which the three tree-trunks were fetched. They had lain for some time buried in the ground (old mud and recent drift-sand); and this might also be inferred from the fact that they were especially well preserved, and not cracked and dry as the trunks are which one finds in the desert, but they were moist, with the bark and bast still fresh. There cannot be the slightest doubt, that these poplars did once grow on the shore of the Schirge-tschapghan arm (the Tokus-tarim), which is described in vol. I chapter XXVII. Nias Baki Bek averred, that 150 years ago the entire flood of the Tarim flowed through this more northern bed, and issued into a lake situated north of the existing Kara-koschun. At that period the basin of the existing lake was nothing but *tschöl* and *gobi*, that is to say »desert». In the time of the bek's grandfather poplars were plentiful beside this northerly arm; but when the stream deserted it in favour of a more southerly course, they withered up and decayed. This information agrees in the minutest detail with the observations which I was shortly afterwards able to make for myself.

If you ask a Loplik, who was born, and has lived all his life, in Abdal, Kum-tschapghan, or Tusun-tschapghan, where the Kara-koschun is, he answers, there is no such lake. And if you ask about the Lop-nor, he is still more mystified. In the case of the latter the reason is that Lop-nor is an old desiccated lake which he has never seen, or even heard speak of; in the case of the former, his reason is that there really is no lake of Kara-koschun. This name is by origin Mongolian, and an old word, which seems to have been applied to the entire region, just as nowadays the Chinese apply the same name to the whole of the district of Tscharklik. Prschevalskij lighted upon the village of Kara-koschun, but was so incautious as to apply the name of Lop-nor to the lake in its vicinity. Kosloff uses sometimes this same name, sometimes the name invented by himself, Kara-koschun-köl.* But, as I have already said, there really is no such name. The different parts of the lake bear different names. Every sheet of open water, that is bordered by shallow thresholds or thick reeds, has its own name; and, as for various reasons these basins change from year to year, so also do their names. The names become, as it were, like the lakes themselves — overgrown with reeds; new basins come into existence and acquire new names. The natives possess no gift of generalisation; it is very rarely that one name is applied to one continuous geographical object. I have already called attention to the fact that the Tarim has several different names, and that the term Tarim is the only one that is applied over a stretch of any great length, and this is simply because it means »river». The same thing applies to the mountain-ranges; the only exception, the Arka-tagh, being scarcely a proper name at all, but rather a descriptive term, »the farther mountains», the purpose in using it being less to distinguish a continuous range than to indicate all the mountain regions that lie *beyond* and *behind* the better known mountains. And it is equally characteristic of the natives to be blind to the fact, that one common name for all the various marshy divisions which are formed by the moribund Tarim would be conducive to order and system. Each man thinks only about the particular part of the great complex of marshes in which he possesses the right to put down his fishing-nets. The compound name Kara-koschun-köl is, from the linguistic point of view, *per se* as unlikely and as objectionable as it would be to write Kara-buran-köl or Lop-nor-köl. To put the invention therefore upon my map is a thing I strongly object to; it is a term which certainly never came from the lips of a native. On the other hand, I have no objection to offer, either on geographical or purely practical grounds, to the retention of the name Kara-koschun, seeing that it is already in existence, although, it is true, it does signify, properly speaking, something else than the lake in question. Did I not on principle dislike to see European names applied to the lakes and mountains of Asia, I should call this basin Lake Prschevalskij, in order to perpetuate once more the memory of the great and able traveller who discovered it, and of the existence of which previous to that discovery we did not possess the faintest inkling. Geographically speaking, it is incorrect to designate the several divisions of the lake by the names Kum-köl, Tojaghun, Usun-köl, etc.; but from the point of view of the native fishermen it is both practical and convenient. As a matter of fact Kara-koschun is nothing but a single marsh, which is continually changing its shape and its appearance. Nevertheless the names of the natives are not without value geographically, in so far as they enable us to discuss more conveniently the different parts of the great lake or marsh. They are also interesting as documents. I would almost venture to wager that within twenty years practically all the names which I have recorded from my visits of 1896, 1900, and 1901 will have disappeared, even if they are not forgotten. Some of them would however still be in use, e. g. Usun-köl, or the Long Lake, Jangi-köl, or the New-Lake, Ajagh-köl, or the Lower Lake, because not only are they characteristic names, but some of them are under all circumstances sufficiently obvious; yet they would then certainly be applied to different sheets of water from those they now indicate.

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* Both these names were, it is true, printed on my map in *Peterm. Mitt.*, Ergzhft. No. 131; but that map was printed when I was absent in Asia, so that I had no opportunity to correct the mistake.

The lake Tojaghun is said to be a fresh creation. It is only two years since it filled with water, and yet it was in this lake that I sounded the greatest depth I obtained anywhere throughout the whole of the Kara-koschun region, namely 4.85 and 5.15 m. This is a matter of very great interest and importance. For one thing, it shows that by the side of the depressions which contain water there exist other dry depressions still deeper, into which the water is only prevented from flowing by intervening ridges and thresholds. Whenever one of these thresholds is broken through, or if it is at any point so low that, when the water rises unusually high it runs over it, then the depression behind it gets filled. Tojaghun is a lake-basin of this character, which has been formed on the north side of Prschevalskij's Kara-koschun.

Why did the lake not expand southwards instead? For the simple reason that in that direction the surface rises towards the foot of the mountains. The rise is, it is true, exceedingly slight at first; but it is at any rate sufficient under the existing conditions of level to prevent any expansion of the lake in that direction. But at some earlier period in the history of the existing lake the volume was sufficiently great, as I had occasion to observe on another excursion, to overflow stretches of country that now lie dry on the southern shore of the Kara-koschun. That the lake in its present condition neither possesses the power to expand southwards, nor exhibits any tendency to do so, I shall prove subsequently. No, the lake expands only towards the north; and why? Since Prschevalskij's basin has become in great part filled up with various materials, the water must of necessity go somewhere; for as the lake grows shallower it is no longer able to accomodate the same quantity of water as in Prschevalskij's time. Its central parts have become overgrown with kamisch, which binds together the æolian dust, drift-sand, river mud, and organic remains, so that, according to the law of communicating vessels, the water must eventually run over and fill the parts which lie lowest. This is the simple and natural explanation of the origin of the lake of Tojaghun, and indeed of all the two-year old sheets of water of which this lake is merely one link. Fig. 90 and 91 give a rough sketch of the relations in question. The cause of the Tojaghun being of a greater depth than the parts of the Kara-koschun that lie next it on the south is also at once perceptible upon comparing the rectangles 1 and 1 *a* in fig. 85. The rectangle 1 represents dry ground, where the erosive and corrasive action of the wind has been at work, so that as time goes on, the soil becomes scooped out, whereas the bottom of the rectangle 1 *a* becomes raised by the sediment deposited on it. Consequently at the moment when the water expands and transcends its bounds, and the lake takes another step towards the north, it is obvious that it is the northernmost depression which is relatively the deepest. The depth is however never adjusted, for from the very first moment of its existence the bottom of the new lake-basin begins to rise, that is provided there is no strong current running through it; then the kamisch gradually establishes itself, and the sediment begins to be deposited in layers along its bottom.

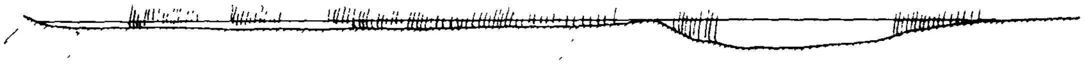

Fig. 90. SHOWING THE RELATIVE DEPTH OF TOJAGHUN.

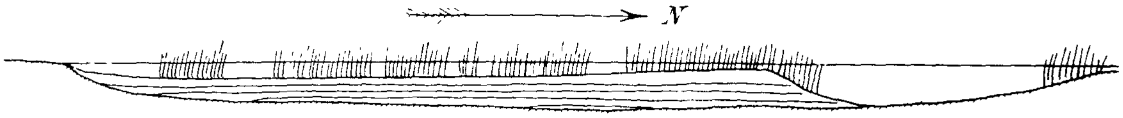

Fig. 91.

We saw the last fishing-net in the eastern part of the Tojaghun; for that is the farthest east that the fishermen go. Beyond that point the fish decrease greatly in quantity, possibly because the water is not perfectly fresh, at all events not so fresh and unvitiated as farther west. This circumstance again is interesting; but the question requires for its elucidation an ampler fund of observations than I have at my command. All the same the natives are unquestionably right, when they declare, it is during the last ten years that the fish have decreased in number; nor is there anything strange in it if they have, for the lake itself is dwindling. I am however unable to explain where the fish go to. Perhaps they have an instinctive premonition that the lake will one day disappear, and consequently retire up-stream and enter the marginal lakes which promise to be more permanent. Difficult though it is to disentangle the intricate delta of the Tarim, it is even more difficult to account for the migrations and wanderings of the fish. It cannot be denied, that in these waters, which change their position and their course so frequently and so suddenly, the conditions under which the fish live are more than ordinarily precarious, and there can be no doubt that many of the changes that take place in the river-beds cause hosts of fish to perish.

Leaving the Tojaghun, we entered a canal running towards the north-east and having a maximum depth of 4.51 m. This led us into the lake of Jäkänlik-köl, this too a very common name in those regions;* in which firm ground exists only on the right, that is towards the south — possibly a long narrow tongue of land, or an elongated island, parting two equally long chains of lakes or strips of water belonging to the Kara-koschun.

On the right the Jäkänlik-köl is entered by a canal, which I was told was the one upon which I rowed in 1896, although I was of course unable to recognise it again, for all these canals are precisely alike. It was however interesting to learn, that almost the whole of the route I then traversed from Kum-tschapghan to Jokanak-köl was now completely overgrown, so that it was no longer possible to force a passage through it with a canoe. True, the people had endeavoured to keep the canals open as long as ever they possibly could by every spring diligently pulling up the freshly sprouting kamisch and jäkän by the roots, but in the long run the vegetation had proved too much for them; and as the canals had also shallowed, and the fish deserted them more and more, the fishermen too had eventually abandoned them to their fate. After the very first year that they abstained from pulling up the reeds, the canals became overgrown to such an extent that it was no longer possible to find them again in that impenetrable *jangal* (jungle). Thus the route I followed in 1896 lay to the right of the route I had thus far pursued, i. e. to Jäkänlik-köl, namely the new, two-year-old waterway farther to the north.

In the Kakmak-tschatschkan-köl there was firm ground towards the north, but the Usun-köl is bordered by firm ground on both sides. The latter gave depths of 2.05, 3.55 and 2.20 m.; these soundings were obtained in the same part of the lake as that in which I got my maximum sounding in 1896, namely 4.25 m. As the soundings in 1896 and those in 1900 were not taken at the same spot, it will serve no purpose to compare them together; indeed in waters that are so changeable as these are, it is scarcely possible to obtain different soundings in the same precise spot. It would not be right therefore to compare 4.25 m., the maximum depth of 1896, with 5.15 m., the maximum depth of 1900, and say that the lake was 90 cm. deeper at the latter date than at the former. The bathymetrical value is in both cases purely accidental. On both occasions I of course measured the places which appeared to be the deepest; still, that would not preclude the existence of even deeper depressions in other places not far away.

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* In 1896 I was told that this name was Jokanak-kol.

Next comes the lake of Ajagh-köl, pretty large in size, which is said to have contained water for 25 years. Before the water came, and it came from the south, the site of the lake is said to have been perfectly dry and barren land. The name, which means properly the Foot Lake, that is the »lowest», »outermost», merely points out the lake which at some time or other was the last, or the most easterly, in which fishing was carried on. But, as I have already said, this is now deserted by fish and fishermen alike, no doubt in consequence of the deterioration in the quality of the water.

Crossing a series of small basins, with a depth of not more than 0.50 m., we came to the Lakone-teresi-kalghan-köl and Schaptik-köl, and finally to the Kanat-baghlaghan-köl, this the largest not only in 1896 but also in 1900. True, the reeds had spread, and their distribution was altered, to such an extent that I should never have recognised the lake again, had not one of my canoe-men, Jaman Kullu, who accompanied me on the earlier trip, and who was with me again now, convinced me that we were travelling over the same route. In 1896 I obtained in this lake soundings of 2.85, 3.15, 3.10, and 2.10 m.; on this occasion (1900) the deepest places were 1.70, 2.50, and 2.05 m. These figures do indeed admit of some comparison, seeing that the soundings were taken in both cases in the deepest parts of the same basin. The mean of the former series is 2.80 m., and of the latter series 2.08 m. Thus there can be no doubt that in the four years the lake had grown shallower; so that in this case it was not pure chance that the lake was found to be 72 cm. shallower in 1900 than in 1896. As the lake grows shallower, the kamisch spreads more and more, and it was there shooting up in parts of the lake which formerly were too deep for it. Consequently the area of open water has decreased considerably since 1896, and yet this was the largest continuous sheet we saw during this present trip. We forced the canoes as far through the kamisch as we possibly could. When we were at length unable by our united efforts to force them any farther, we set fire to the reeds, drawing back until they had cooled down, after which we continued again. In the end however we were obliged to desist: it was quite impossible to proceed farther. The old strong reeds had been broken down by wind and storm in sheaves so big and thick that we could easily have walked upon them without any risk whatever of dropping through, nor was there any side-passage through these hard, coarse reed-stalks where it would have been possible to work the canoes. Behind this impenetrable barrier lay the lake-basin of Turkomak-köl, which I crossed over in a canoe in 1896, but which is now everywhere inaccessible. Its name will soon be forgotten. Jaman Kullu estimated the distance between the point to which we now penetrated and the point we reached in 1896 to be equal to the distance between the eastern end of the Lakone-teresi-kalghan-köl and the point where we were now stopped. Accepting the data given by my velocity-instrument, this distance amounted, I calculated, to 6277 m., which agrees approximately with my former map in *Petermanns Mitteilungen*, for it makes this same distance to be about 6 km. Thus in the course of four years the navigable area of the Kara-koschun was shortened by no less than 6 km. If the vegetation continues to gain ground at the same rate, the marsh will be impassable in 25 years. This however cannot take place, because, in the first place, the encroachment the vegetation advances increasingly slowly towards the west, where a strong current still flows, and because, in the second place, the point at which we were stopped in 1900 is probably a relatively shallow threshold or bank, bearing an exceptionally rich crop of reeds; whereas the Turkomak-köl was no doubt still in great part open and free from reeds. Nevertheless it not only *can* happen, but probably also *will* happen, that *within* 25 years the *existing* Kara-koschun will be everywhere impassable; but the reason will be, that ere that time the water will already have sought out another basin (see below). Whereas Prschevalskij in 1876 was able to paddle all the way to the village of Kara-koschun, and I in 1896 was able to get only as far as the farther extremity of the Turkomak-köl, in 1900 I was not able to reach even the beginning of this lake. Along this waterway therefore the marsh is growing smaller year by year, while the water is spreading northwards over tracts which at the time of Prschevalskij's visit belonged to the desert. According to the statements of the natives, there are but few sheets of open water to the east of the Turkomak-köl. Beyond this lake there is nothing except kamisch, and it extends a pretty long way towards the north-east, until finally it thins out and disappears, whereupon the desert from the north and from the east close in round this dwindling lake-basin, which is advancing with giant strides to its destruction. On the whole, the lake was said to be just then, at the time of our visit, at its highest level for the year. From that time its level would drop every day, until in the summer it becomes so low that not even the smallest canoe is able to get over the low thresholds on the way to Ajagh-köl: the farthest place to which they can advance is the upper part of the Usun-köl. At the point where we turned back, the water becomes brackish, but not bad enough to make it undrinkable. The Kara-koschun rises again in October, when the real spring-flood from the mountains at length succeeds in reaching these remote regions, though it does not then rise as high as it does in April. For during the summer evaporation is active, and large quantities of water are required to make good the loss. But when the lake

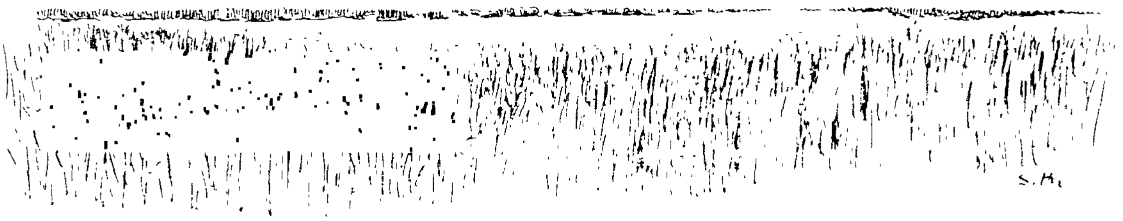


Fig. 92. THE EASTERN PART OF KARA-KOSCHUN, AS SEEN FROM A MOUND ON THE NORTHERN SHORE, IN 1896.

freezes, it is pretty full of water, and the icy covering protects it against excessive evaporation. When the spring-flood reaches it, its level is already considerably higher than in the autumn.

After spending the night on the shore of the Tojaghun, we returned on the 9th April to Kum-tschapghan. That day the temperature did not rise above 12° C., and the wind blew from the north-east with a velocity of 8 m. in the second. The fresh green shoots of the kamisch were only 1½ dm. above the surface of the water, and they were still thin.

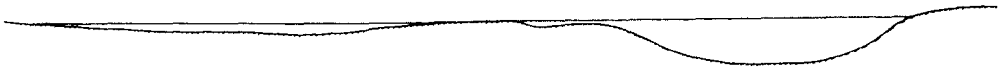


Fig. 93. DIFFERENCE OF DEPTH IN THE SOUTHERN AND NORTHERN PART OF KARA-KOSCHUN.

On the 11th April I made an excursion by canoe along the southern waterway; for there are but two, the one which begins with the Kum-tschapghan branch of the Tarim — this I have just described — and the other which begins at the Tusun-tschapghan branch. This latter flows with a rather lively current towards the east-south-east, winding but little. Its volume decreases however very soon, for it gives off on the right thirteen small branches, each about one meter broad, which go to form the most southerly lakes of the Kara-koschun. These I will describe presently. The thirteen little channels are said to have originated three years ago, or in 1897, and every year they get bigger. Beyond doubt they have started since the central parts of the Kara-koschun became filled with kamisch and other material, checking the flow of the water eastwards, and compelling it to spread out over its banks in the lowest part of its course. This would seem as though the Kara-koschun were manifesting a tendency to shift its position towards the south; but that is not really so. The lakes of Abdal are also the result of this tendency of the lower Tarim to break up into deltaic arms, for they too are fed by affluents through the right bank of the river. These terminal lakes show rather a tendency to travel back, as it were, up-stream, as Bogdanovitsch pointed out.

At Istam-tschapghan we left the river behind us, to flow on, greatly reduced, to Tusun-tschapghan, while we steered south-east through the thick kamisch. The canal we followed entered the Uktu-köl, which has direct connection with the Bajat-köl. It is here that the people of Tusun-tschapghan have their most profitable fishing-grounds. The greatest depth here was 1.61 m., and in the next following lake, the Ottora-köl, I obtained the maximum sounding of the day, namely 1.90 m. As a rule, however, it is seldom that the depth exceeds 1.0 m.; and after we had traversed the Jäkänlik-köl and the Ajagh-köl, and a whole series of small confined basins running south-east, until we came out upon the Sate-köl, we found that the depth was rarely as much as 0.3 m. Upon comparing the maximum depth in the north (5.15 m.) of the Kara-koschun and the maximum depth in the south (1.90 m.), we find that in the former quarter the lake is nearly three times as deep as in the south; but when we compare the mean depths of all the soundings along the northern and southern waterways, we find that the figure for the former is nearly six times the figure for the latter. This is illustrated in fig. 93. South of the Kara-koschun lie the border-ranges of the Tibetan highlands, north of it the Desert of Lop. Now in a lake situated at the foot of a big mountain-range, it is usual to find its deepest depression in the part which lies nearest to the foot of the mountains, as we shall find to be the case in several lakes when we come to deal with Tibet. The vertical section of the Kara-koschun ought therefore to be like that shown in the upper cut of fig. 94, whereas in reality it is as shown in the lower cut of fig. 94. Since, then, the form of the depression is like this, it ought to excite no surprise to find that the lake is flitting northwards.

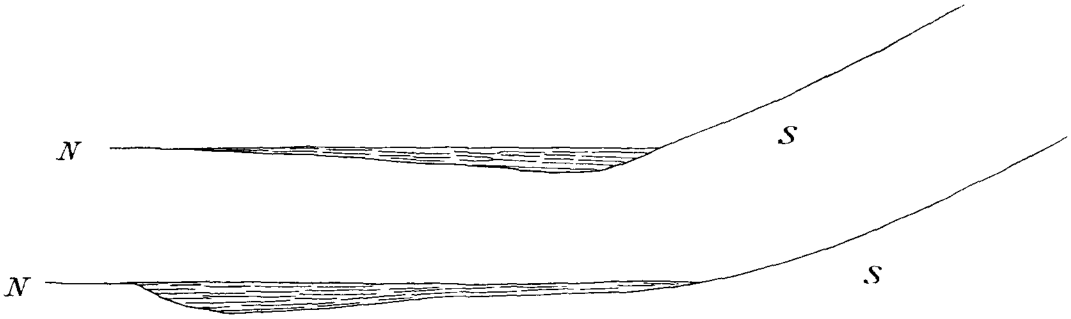


Fig. 94. PRESUMPTIVE AND REAL SECTION OF KARA-KOSCHUN.

*Jäkän* and *turkomak* are far more plentiful in this part than kamisch; the last-named is thin and poor, and does not seem to thrive. Wild-duck, wild-geese, and fish are also fewer than in the northern parts; in the Sate-köl they are practically absent altogether. Across this lake, and its next continuation, the Tais-köl, or the Shallow Lake, our course was nearly due east. In point of fact, these two form one lake, both pretty uniform in breadth, nearly a couple of kilometers, and bordered on the south by firm ground, and on the north by a thick belt of *jäkän;* this last prevented us from travelling along the deeper parts of the lake. Where we paddled the depth was, as I have said, 0.3 m.; but southwards the lake shallowed more and more towards the black line of the saliferous and absolutely barren *schor*, which forms the margin of the lake on that side. It is there that the road to Dung-chan (Tung-chuan) runs, marked in a few places by *nischans* of branches, to show the direction it takes. At intervals too there are low mounds, some with dead tamarisks, others with living. The whole of the area of the lake which lay south of our route was open and bare of vegetation, and on that side we passed only a few clusters and islands of jäkän and turkomak. Otherwise the bottom of the lake is perfectly barren; I failed to detect even a single Alga. Thus from the beginning of the shallow part of the Sate-köl, all faunal life ceases; even the fish do not venture to invade these shallow, tepid, and not perfectly fresh waters. The lake-bottom is not covered with sand, but with fine yellow mud resting immediately upon black ooze or blue clay, which at the least touch of the paddle boils up like ink. Walking across it, you sink in to the depth of 1 dm., but underneath the ooze and the clay there is firm ground, namely a saliferous layer as hard as stone. With this hard white salt — we had great difficulty in chipping a piece off with a paddle — only 1 dm. below the soft sedimentary matter it is astonishing that the water of the lake is as fresh as it actually is. This salt layer was deposited in a desert lake that was drying up and disappearing; and there can exist no doubt that it marks an earlier stage in the migration of the Lop-nor — perhaps this was the position of the lake before it travelled north. Not having implements with me, I was unable to measure the thickness of the salt deposit; but from what my canoe-men told me, and they fetch salt from that place in summer, partly for their own use, partly for sale in Tscharklik, the maximum thickness approaches 85 cm., though in one place, namely where we landed, the thickness decreases to 10 cm.

In the part of the lake called Avugh-köli, there juts out from the southern shore a flat cape, on which stands a nischan consisting of a faggot of branches; it is there that the Dung-chan-jol, or road to Tung-chuan, divides. While the right branch goes up into the mountains *viâ* Dunglik and Tatlik-bulak, the left branch continues on through the desert of Gobi to the town already mentioned, and is said to traverse *schor* and *tschöl*, i. e. a salt surface and desert. This branch seems to swing away from the Kara-koschun; I say »seems», because it is impossible to obtain, even from those who have travelled that way, really trustworthy information as to how far the marsh and its kamisch-beds extend to the east. A little east of the cape there was a black round island projecting about one foot above the surface. Towards this we steered, with the intention of landing on it; but it was by no means so easy, for the canoes soon stuck fast in the mud and we had to plough our way on foot through the ooze and slush. At length we reached the road, which runs through a country absolutely destitute of organic life. The soil was genuine schor, that is a blend of dust and clay, perfectly dry and hard, and broken into »warts» and »blisters», which looked as if they had been formed by gases whilst the ground was still moist. Close to the water-line there was a belt of a different consistency, namely perfectly level silt, yellow, almost white in colour, and only recently exposed in consequence of the shrinkage of the lake.

Still farther east this long lake grows so shallow, that we had perforce to paddle amongst the jäkän in order to make any progress at all. One of the small lakes we crossed over is called Jäkänlik-köl, while the most easterly part of the big lake is called Gölme-kätgen-köl, or the Lake of the Lost Fishing-net, a name which proves that fishing was, at any rate formerly, carried on there. At the present time the Ajagh-köl marks the eastern limit of regular fishing along this southern waterway, although the people do occasionally put down their nets in the *jangal* north of the Sate-köl. East of a schor island, which occupies the greater part of the breadth of the Gölme-kätgen, the water was so shallow that the canoes would no longer float, but had to be dragged. At length even that was no longer possible, and then we stopped. The water there was a light yellow, showing the reflection of the bottom, which is everywhere covered with a layer of fine yellow silt, the product of atmospheric dust. The greatest depth near the point where we turned back was 19 cm.; but large portions of the lake-bottom were either wholly exposed or just flush with the surface of the water. And yet there was a slight current, its velocity being 0.17 m. in the second. It proceeded towards the north and north-east, where the vegetation was thick and luxuriant. Large areas of both jäkän and kamisch were broken off level about 25 cm above the water-surface, and as the broken stalks all pointed towards the west and south-west, it was manifestly the wind which had mowed them down. This pointed to the occurrence of an early spring storm, before the ice broke up, for the water would not be resistant enough to serve as a fulcrum against which the stalks could be snapped. The ice was said to have broken up here in the beginning of March, whereupon the surface, owing to the influx of the spring-flood, had risen; but quite recently it had begun to drop again, and during the last few days had subsided pretty rapidly. Still a drop of 25 cm. since the break-up of the ice is unexpectedly large, especially as only two days before we had been told in the northern part of the Kara-koschun, that the water there was unusually high. It is not likely that the northern and the southern waterways are everywhere separated by a strip of firm land, such as would allow one-half of the lake to stand at a higher level than the other half in virtue of a greater influx. This might indeed be conceivable were the left arm of the Tarim greater than the right arm; but, as an actual fact, the Kum-tschapghan arm, which goes to the northern waterway, is smaller than the Tusun-tschapghan arm, which leads to the Sate-köl, where this big drop took place. Possibly a large percentage of the water of the Tusun-tschapghan finds its way northwards by winding passages, and the Sate-köl is also possibly in great part cut off from the north, so that in reality it does drop more quickly than the other part of the marsh. It is likewise just possible, that the broken stalks were survivals from an earlier year, when the levels were different.

In point of area the linked lakes Sate-köl and Gölme-kätgen-köl must be the largest sheet of open water in the whole of the Kara-koschun, considerably larger in fact than the Kanat-baghlaghan-köl. But there is a great difference between the two basins. In the latter there is water all the year round; it is however ten times as deep as the Sate-köl, which receives no farther influx after the early summer, so that it contracts, becomes salt, and dries up completely, exposing the hard yellow clay, which cracks into polygonal saucer-like patches, with upturned edges. The kamisch and jäkän are shrivelling up, and survive only in the *jangal* in the deeper water. This will explain why the vegetation in these linked lakes is so thin and poor. Fifteen years ago, before these lakes were formed, their sites were dry land; but when the central parts of the Kara-koschun became overgrown with kamisch, the water there was literally forced to flow over into the adjacent parts, and it was then that these lakes originated. The southern lakes dried up completely for the first time in the summer of 1898, though they filled again in the following autumn. Since then the water has diminished at an increasing ratio, and in the year of my visit not one of the fishermen of Tusun-tschapghan had been over tho these regions. The year before there were still some fish, but that year they had completely disappeared, having no doubt a premonition that the day of these lakes is past.

Unfortunately my plans never allowed me time to go round the eastern end of the Kara-koschun, and not even a single living native has ever visited that part of the lake. There is nothing to attract them on the border-lands between the decaying kamisch-fields and the desert. All I could learn from one old man was, that $^1/_2$ to $^3/_4$ km. north-east or east-north-east of the point where we turned back there lay the district of Kugek; and that by the Dung-chan road it was about one day's journey to Latschin. Some years ago the long linked lakes had continued a good bit farther towards the east-north-east. The easternmost basin is called Soloma, though there is not a drop of water left in it, and it is now completely inaccessible. My informant, who visited Latschin twenty-one years ago, told me that over against Latschin the open water came at that time to an end, and for a day's journey farther there was thick kamisch; that was followed by a belt of dead kamisch, which gradually merged into the desert. If such was the case 21 years ago, it must be even more true at the present time; indeed it is most likely that even more extensive areas of fresh kamisch have died since then.

# CHAPTER XI.

## VOLUMES OF THE TARIM, JURT-TSCHAPGHAN AND KUM-TSCHAPGHAN.

Before I proceed to describe the embouchure of the Tarim into the Kara-koschun, it will be expedient to deal with the last remaining portion of the river's course. We started for Jurt-tschapghan on 12th April, sending the caravan along the left, or north, bank of the river, where it had to cross over thirteen canals, which break away along that stretch and pour their water into the lake-basin that we touched when we travelled along the northern shore of the Kara-koschun, and the united outflow stream of which we crossed over on 7th April when on the way to Kum-tschapghan. I myself, accompanied by two men to paddle, proceeded up

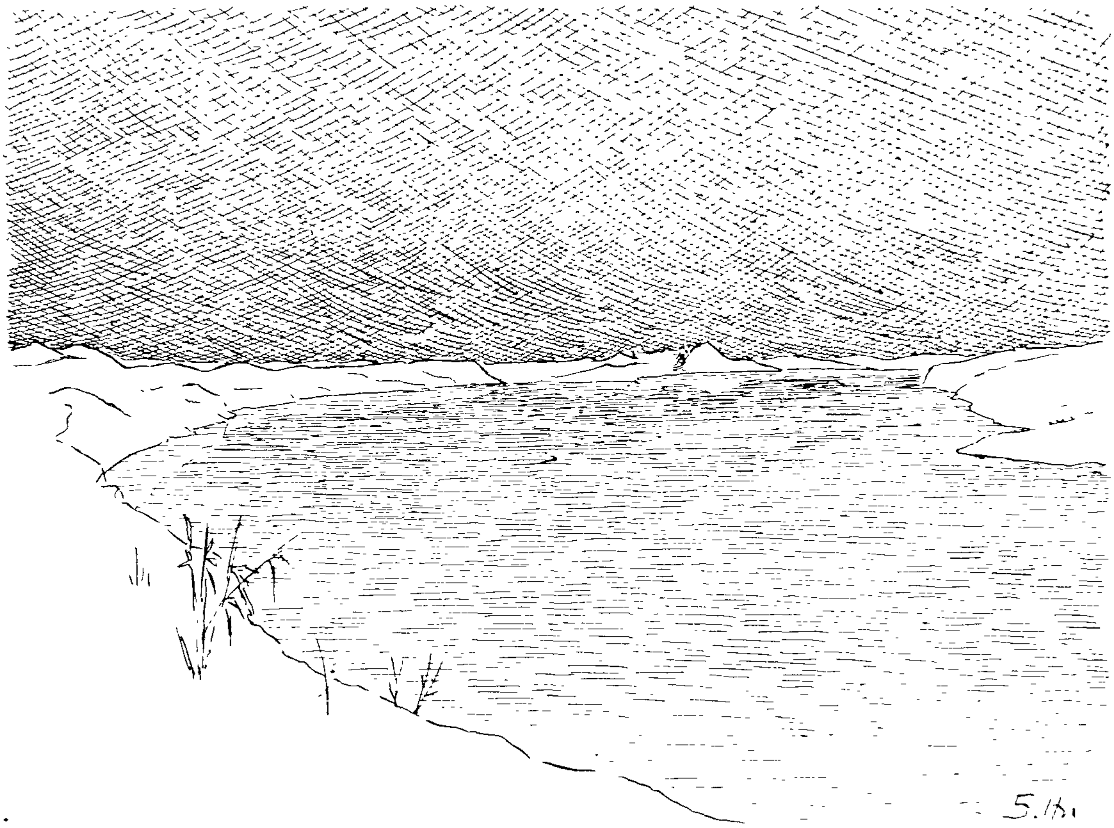
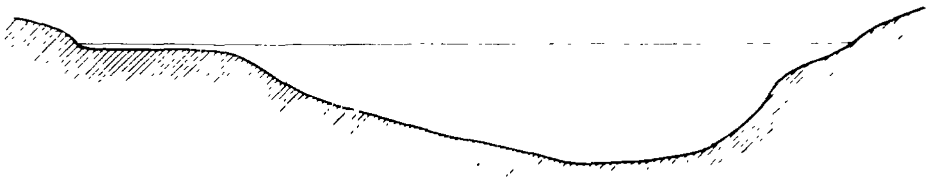


Fig. 95. THE TARIM A SHORT DISTANCE ABOVE JURT-TSCHAPGHAN.

the river in a canoe. The stream grew stronger the higher we advanced. Its left bank was plentifully supplied with reeds, so that we seldom saw the canals which break away from it along that part. On the same side too there are some tamarisk-mounds, but none on the right, or southern bank, which is flat and bare all the way to the edge of the kamisch-beds, a distance of a few dozen meters. On the whole the left bank is the higher, as well as the more definitely marked of the two. On the right we observed five canals, the last of them called Tughdake-tschapghan, all entering marshes that are connected with the lakes we visited on our second excursion along the Kara-koschun (see the preceding chapter). Entering the sixth canal, Jol-tschapghan, we left the river behind us, and from that point paddled on the lakes. These are identical with those which I have called by the general name of the lakes of Abdal. On this occasion they were distinctly larger and more expanded than in 1896. In the vicinity of Kötschök-attamning-köli (Kutschuk-attam) we sounded a depth of 2.70 m., though there were stated to be greater depths on both sides of our route. The lake of Kajul (Karaul?)-köl is relatively large. This, as well as those just alluded to, have come into existence within the last two years. Then follows Kamuschluk-köli and Turkomaklik-köli. From the beginning of the Usun-köl, I perceived to the N. 33° E., and at the distance of two or three hundred meters, Kuntschekan Bek's Abdal, where I stayed for a time four years before. Although the huts still remained, they were surrounded on all sides by water. At length the lakes grew both shallower and narrower, and the kamisch came to an end, while here and there a tamarisk, growing, not on the usual mound, but upon the level ground, emerged above the water; it was between these that we paddled, except where the depth was so slight that we had to drag our canoes. The lake extended all the way to the village of Jurt-tschapghan, close to the wall of the fort. It was three years before (1897) that the inhabitants of Abdal were compelled by newly formed marshes and lakes, which threatened to cut them off from the road to Tscharklik, to remove to this place, and it was here that old Kuntschekan Bek died in 1898. Thus Abdal is a movable entity, a place of transitory existence. One hears of Kona-Abdals and Jangi-Abdals in various quarters; the oldest Abdal of all lies north of the existing waterway, on the bank of the Schirge-tschapghan arm and near its lakes.



| Fig. 96. Right. | 0.32 | 0.36 | 2.33 | 3.62 | 4.71 | 5.50 | 6.45 | 6.30 | 5.58 | 1.84 | = depth. Left. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 22 | 52 | 58 | 59 | 67 | 56 | 68 | 33 | |
| | 0 | 0 | 30 | 63 | 58 | 69 | 79 | 80 | 72 | 49 | |
| | | | 34 | 66 | 68 | 67 | 76 | 79 | 80 | 40 | |
| | | | 29 | 60 | 68 | 62 | 81 | 81 | 77 | 28 | velocity. |
| | | | 42 | 62 | 62 | 62 | 79 | 83 | 84 | | |
| | | | 38 | | | | | | | | |
| | | | 0 | | | | | | | | |

Breadth = 42.4 m. Jurt-tschapghan, April 13. Scale 1 : 400.

At the present moment there is no Abdal that is inhabited, for the district around the existing village has long been called Jurt-tschapghan. But even this situation appears to be in danger, for it is surrounded on every side by marshes and lakes.

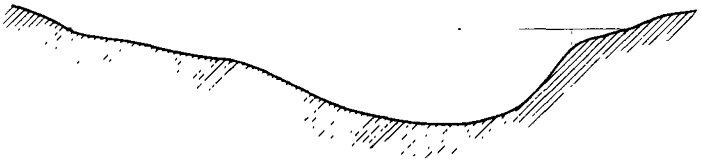


Fig. 97.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Left. | 0.63 | 1.18 | 1.67 | 2.96 | 4.30 | 4.93 | 5.09 | 4.33 | 0.87 | = depth. Right. |
| | 20 | 33 | 40 | 41 | 55 | 48 | 40 | 19 | 0 | velocity. |
| | 23 | 30 | 33 | 35 | 44 | 38 | 40 | 18 | 0 | |
| | | | 28 | 41 | 41 | 34 | 50 | 33 | | |
| | | | | | 38 | 44 | 39 | 33 | | |
| | | | | | 47 | 28 | 47 | 29 | | |

Breadth = 30.0 m. Tarim at Kum-tschapghan, April 10. Scale 1 : 400.

Measuring the river at Jurt-tschapghan on 13th April, I obtained the following result — breadth, 42.4 m.; mean depth, 3.365 m.; mean velocity, 0.6023 m. in the second; and volume, 85.91 cub.m. in the second. I have already stated, that at Schirge-tschapghan on 19th April the river had a volume of 101.86 cub. m. in the second, or 16 cub.m. more than at Jurt-tschapghan, although the measurement there was made six days later, at a time when as a rule the river is subsiding, and without taking into account the influx of the Tschertschen-darja, though it was then, I admit, insignificant, for its spring-flood does not get down to these lakes until the early summer. The difference of volume was unexpected, because the river gives off no canals above Jurt-tschapghan. It must therefore be accepted as a proof of the enervation which overtakes the Tarim before it reaches the Kara-koschun, an enervation which can only be ascribed to the extremely heavy evaporation that goes on, conjoined with the absorption of the water into the ground.

Along the short stretch betwen Jurt-tschapghan and Kum-tschapghan the loss of volume is enormous, the cause in this case being the great number of side-canals, which like a delta spread the water out before it enters the terminal basin. The following measurements, made on 10th April, serve to illustrate these points. At Kum-tschapghan the river had the following dimensions — breadth, 30.0 m.; mean depth, 2.601 m.; mean velocity, 0.3363 m. in the second; and volume, 26.24 cub.m. in the second. These data were obtained just above the point where the river divides, and where the water was flowing

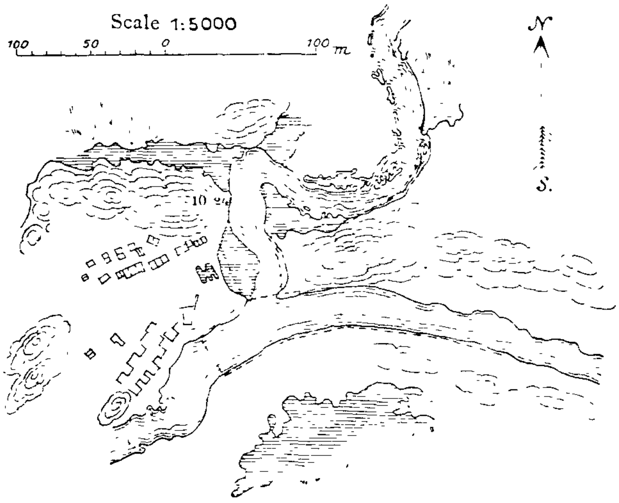
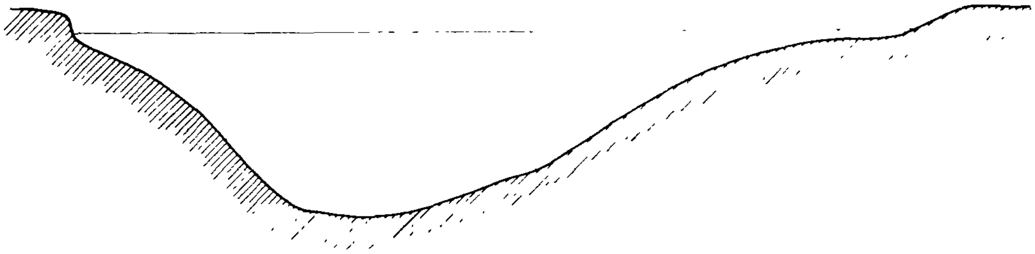


Fig. 98. THE KUM-TSCHAPGHAN AND TUSUN-TSCHAPGHAN ANNO 1900.

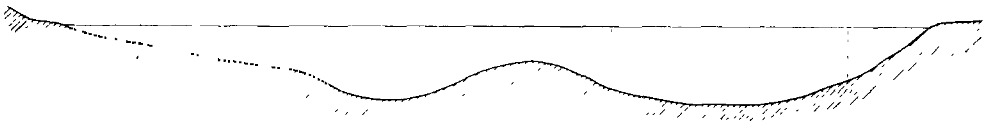
steadily downwards without eddy or back-stream, though there was a narrow belt of stationary water under the right bank. This bank was low, with marshes and tiny pools of a score or so meters to the south of it. The opposite bank, where the huts of the village stand in two rows, is more accentuated and higher, namely 1 ½ m.



| Fig. 99. Left. | 1.06 | 2.87 | 4.67 | 4.80 | 4.36 | 3.75 | 2.41 | 1.30 | 0.62 | 0.16 | = depth. Right. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 49 | 60 | 39 | 39 | 34 | 35 | 35 | 31 | 28 | 28 | velocity. |
| | 21 | 54 | 51 | 28 | 37 | 32 | 30 | 38 | 9 | | |
| | | 42 | 45 | 41 | 39 | 37 | 26 | | | | |
| | | | 46 | 48 | 40 | 41 | | | | | |
| | | | | 49 | 50 | 41 | | | | | |

Breadth = 22.0 m. Tusun-tschapghan branch, April 10. Scale 1 : 200.

With the view of controlling the results I have just given, as well as of ascertaining how much of the water went to the north and how much to the south, I took the following measurements immediately afterwards in the two riverarms separately, which in plan resemble a hay-fork (fig. 98). The Tusun-tschapghan arm had a breadth of 22.0 m.; a mean depth of 2.364 m.; a mean velocity of 0.3729 m.; and a volume of 19.39 cub.m. in the second. The left bank, against which the most powerful part of the stream was driven, is 1 m. high, and vertical, and farther down rises slowly up towards some old dunes, bound together with vegetation; consequently they are contained between the two river-arms, and thus serve as a memorial of the time when the drift-sand was able to spread freely westwards in this part of the country as well. The right bank rises into a low rampart, behind which, on the south, are marshes.



| Fig. 100. Left. | 0.46 | 0.88 | 1.16 | 1.38 | 1.48 | 0.86 | 1.63 | 1.99 | 1.96 | 1.37 | = depth. Right. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 2 | 6 | 31 | 29 | 18 | 43 | 40 | 57 | 67 | velocity. |
| | 2 | 4 | 10 | 28 | 26 | 21 | 42 | 58 | 50 | 60 | |
| | | | | 27 | 24 | | 40 | 43 | 50 | 10 | |

Breadth = 22.6 m. Kum-tschapghan branch, April 10. Scale 1 : 200.

The Kum-tschapghan arm on the left had a breadth of 22.6 m.; a mean depth of 1.243 m.; a mean velocity of 0.3055 m.; and a volume of 8.58 m. in the second. Here the left bank ascends to the highest dune-hill, bound by vegetation, that there is in that region, its altitude being 10.24 m.; but the right side of the stream is occupied by a silt-deposit at the very verge of the water. This applies however only to the cross-section where the measurements were made, as depicted in the accompanying figure (100). From the same figure we may also see, that there is an elevation or bank in the middle of the stream, with only 0.86 m. depth. Just below the place of measurement the left bank is lined by a string of alluvial mud islands, forming a sort of temporary barrier against the big marsh which extends immediately north of it, and is fed by the canals that issue from the left bank of the Tarim between Kum-tschapghan and Jurt-tschapghan. The volume of the two arms thus amounted to 27.97 cub.m., as compared with 26.24 cub.m. in the undivided main channel higher up. Consequently there is a difference between the two sets of measurements of 1.73 cub.m. The results obtained at the twenty points in the two arms are no doubt more reliable than those obtained at the nine points in the main undivided stream. There is however this difference, that in the former case the result is affected by four banks, whereas in the latter case there are only two concerned. We may take the mean between the two measured volumes, or 27.10 cub.m., as being the actual volume at the moment of measurement (see vol. I p. 32).

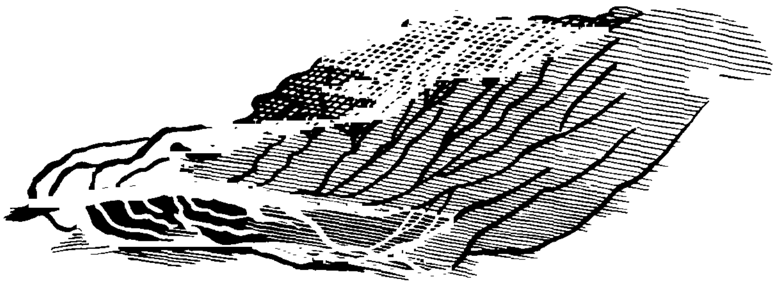


Fig. 101. DISTRIBUTION OF WATER IN THE KARA-KOSCHUN.

The volumes of the two arms, when compared together, are as 2.26 to 1, that is to say the Tusun arm is 2¼ times as great as the Kum arm. Nor is this surprising; for a glance at the map will show that the Tusun-tschapghan branch is the real continuation of the Tarim; while the Kum-tschapghan arm breaks away from it at right angles, and in respect of its volume is exceeded by two or three of the arms which separate themselves from the river higher up. In spite however of this great difference of volume, we have found that the northern parts of the Kara-koschun, to which the smaller arm makes its way, are year by year increasing, and possess a far greater abundance of water than the southern parts, which are dwindling, despite the influx that they receive from the great Tusun-tschapghan arm. The annexed illustration (fig. 101) gives a schematic view of the situation, the depth of shading corresponding to the relative abundance of water. There is a crossing like that which occurs in the case of the optic nerves. Of this only one explanation, and that a quite natural explanation, is conceivable. It is this: the main body of the Tusun-tschapghan water likewise proceeds to the north, though it is by a roundabout way, and its ramifications are connected with the northern parts of the Kara-koschun in the manner shown in the illustration. Water is also streaming northwards through the reeds from the southern parts of the marsh. This is the only conceivable explanation, for the 9 cub.m. of the Kum-tschapghan could not possibly be sufficient to fill the northern parts of the marsh, which go on widening out towards the north. Lower down I shall be able to offer a striking proof of the correctness of my reasoning.

On 13th April we obtained at Jurt-tschapghan a volume of 85.91 cub.m., and on 10th April at Kum-tschapghan a volume of 26.24 cub.m., both measurements in the main undivided stream. Thus in this short stretch of 20 km. the river lost not less than 59.67 cub.m., notwithstanding that at that particular season of the year it was, as I have already said, subsiding. More than two-thirds of this amount enters the marginal lakes which on both sides are connected with the Kara-koschun. Some of the canals through the containing banks by which it enters are natural (*atscha*), others are dug (*tschapghan*). The largest of these is situated just below old Abdal, and is said to be more than half as big as the Tarim at Kum-tschapghan, and consequently much bigger than the Kum-tschapghan arm. The Jol-tschapghan, the canal by which we paddled out upon the Abdal lakes, may have a volume of 3 to 4 cub.m. The greater part of the 59.67 cub.m. goes however to the left, and thus serves to augment directly the northern Kara-koschun. It was here that the caravan had to cross over the thirteen canals, most of them 60 to 70 cm. deep, three with 80 to 85 cm., and one, the deepest of all, with 1.08 m. In all the water flowed very swiftly, and two or three of them were difficult to ford with camels. Four large canal-arms were dammed with tamarisk-branches, kamisch and earth, the natives being afraid that, unless they did this, their pasture-grounds would be completely flooded.

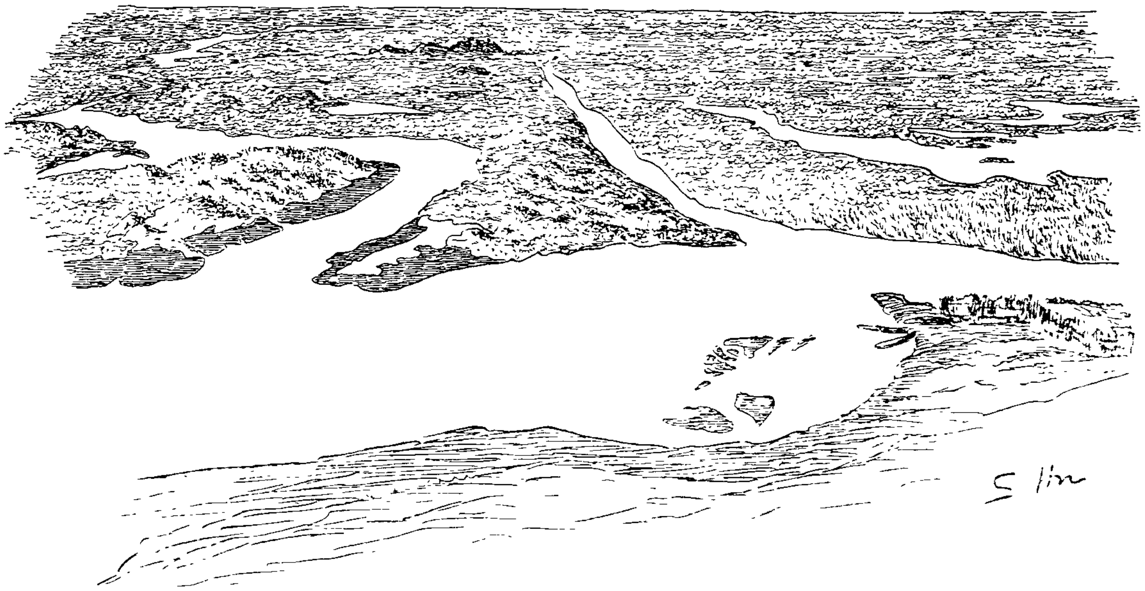
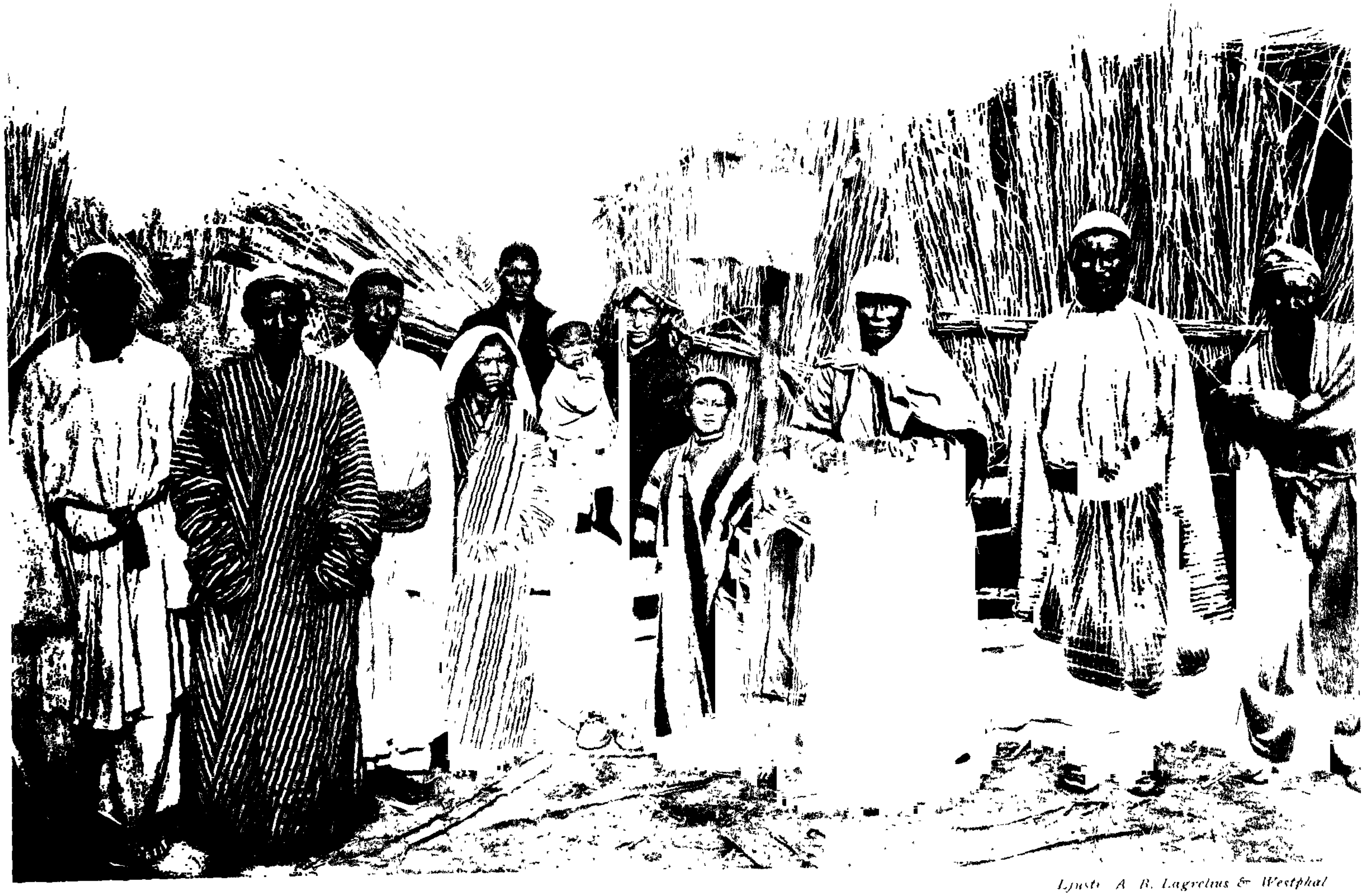


Fig. 102. VIEW TO THE EAST FROM THE TOP OF THE HIGHEST DUNE-MOUND AT KUM-TSCHAPGHAN. THIS IS THE REAL DELTA, WHERE THE TARIM DISSAPEARS IN THE MARSHES OF KARA-KOSCHUN (DRAWN IN 1896).

Numet Bek had observed, quite correctly, that the lakes are travelling, so to speak, up the river, that is to say, to the west. Some thirty years ago he and other natives had huts and flocks of sheep at Soloma, but ever since then they have

Pl. 12.



Ljustr. A. B. Lagrelius & Westphal

INHABITANTS OF JURT-TSCHAPGHAN (ABDAL).

The second from the right is Tokta Ahun son of Kuntschekan Bek.

been flitting step by step towards the west, their last move being three years ago from Abdal to Jurt-tschapghan; and this place they will again have to abandon soon, owing to the origination of fresh marginal lakes where formerly it was dry ground.

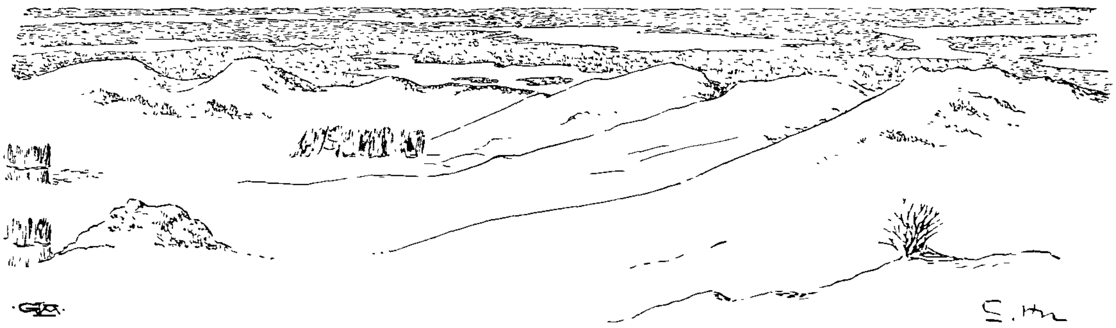


Fig. 103. VIEW TO THE NW FROM THE SAME POINT.

With regard to the river at Jurt-tschapghan, I was told, that it was then (13th April) at its highest level, and that it would drop every day after that, at first slowly, then more quickly, until it reached its lowest ebb, in the end of the summer and the beginning of the autumn. At that stage the river is said to be 1½ kulatsch (2.55 m.) lower than it was in April; and, judging from the following measurement, which I made at the same place on 25th June of the same year, that is not at all improbable. Then the breadth was 37.2 m., the mean depth 3.371 m., the mean velocity 0.3143 m., and the volume 39.41 cub.m. in the second. Thus in the 2½ months the river had dropped from 85.91 cub.m. to 39.41 cub.m., or a loss of 46.5 cub.m., and supposing the volume continued to decrease at the same rate through July, August, and a part of September, there would not be much water left in the bed when the autumn high water arrived. Unfortunately the two measurements were not made at *precisely* the same spot, for the latter soundings were taken in a deeper part of the bed. The determining factor is however the velocity,

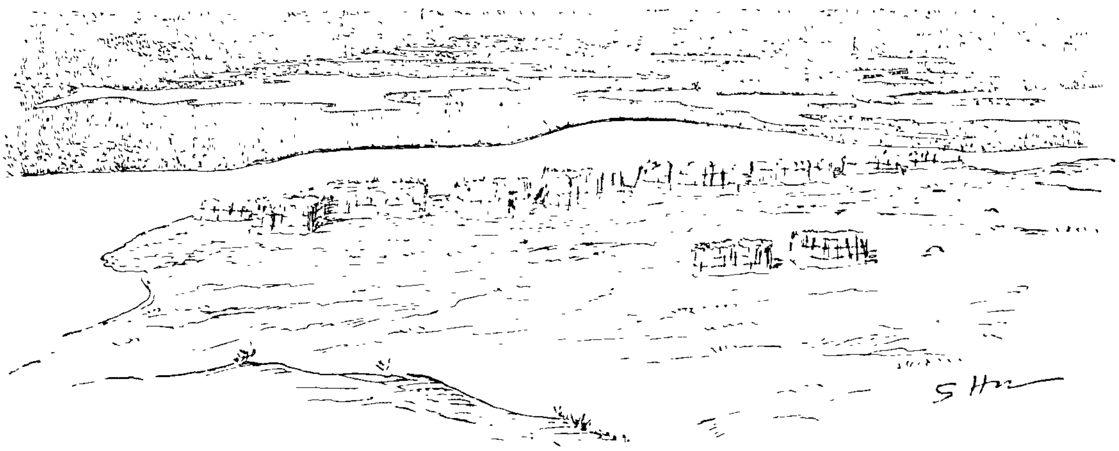


Fig. 104. VIEW TO THE SOUTH FROM THE SAME POINT. IN THE FOREGROUND THE SATMAS OF KUM-TSCHAPGHAN AND BEHIND THEM THE VERY END OF THE TARIM RIVER.

and this on 13th April was 0.6023 m., and on 25th June 0.3143 m. in the second, or about one-half as great, although one would expect that the suction which the rapidly evaporating marshes would exercise upon the lower part of the river's course would result in a pretty swift stream during the low-water period. It may however be that the rate of fall during July and August is not so great as I have supposed, for if it were the bed would run absolutely dry. Had the river actually experienced a drop of 2.55 m., its breadth at the place where the second measurements were made would still have been 26 m. What really seems to happen is this: whilst the bed remains in great part full of water, the velocity continues to decrease, perhaps under certain circumstances ceases altogether. This will be more readily understood after contemplation of the annexed section, showing the bathymetrical relations in the lower Tarim and the Kara-koschun, which I made during my visit in 1896. From that we see that the maximum depth of the river was 8.80 m. and the maximum depth of the lake 4.25 m. In 1900 the maximum depths of the river and lake were 6.45 m. and 5.15 m. respectively, though I ought to add that the former is the deepest sounding along an arbitrarily chosen line; while on the whole the depth of the Kara-koschun is only 1 to 2 m., indeed, taking the mean, it is certainly much less. I should estimate the mean depth of the lower Tarim to be three times as great as the mean depth of the Kara-koschun. It is true, the river drops, as we have already seen, very appreciably in the summer. Most of the southern lake-basins dry up completely, and many of those in the north, having their inflow cut off, become salt. If now the supply to the lower Tarim is diminished to the extraordinary extent shown by the two measurements we are discussing, and if the fall in the lowermost part of the Tarim is so insignificant, then it is clear that the latter is the actual recipient of the water, that is it acts as a reservoir into which is collected the summer water of the entire river-system. If by any chance the surface of the

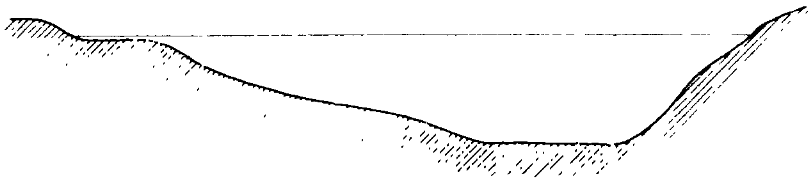


Fig. 105.

| Right. | 0.12 | 1.83 | 3.02 | 3.84 | 4.50 | 5.52 | 5.97 | 5.98 | 2.83 | = depth. Left. |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 15 | 28 | 33 | 33 | 38 | 39 | 32 | 18 | velocity. |
| | 0 | 23 | 30 | 32 | 39 | 34 | 41 | 39 | 19 | |
| | | 24 | 34 | 36 | 36 | 36 | 40 | 36 | 29 | |
| | | | | | 33 | 34 | 40 | 41 | | |

Breadth = 37.2 m. Tarim at Jurt-tschapghan, June 25. Scale 1 : 400.

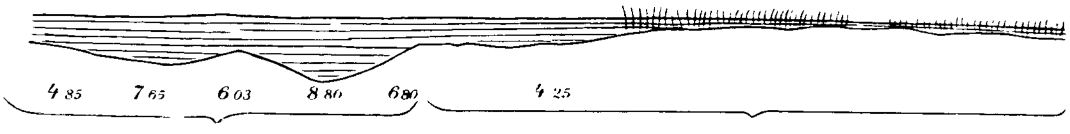


Fig. 106.

Kara-koschun happens to be higher than the level of the river, its water may actually flow backwards up the river. This is the train of reasoning which was suggested to me by the statement, that in summer the river drops 2.55 m. In 1896 Kuntschekan Bek told me, that the difference between high water and low water amounted to 2½ to 3 kulatsch, or 4 to 5 m.; and at a later date I ascertained myself that there was a drop of more than one-half in the space of 2½ months. Considering then that on 8th April the maximum depth of the Kara-koschun was 5.15 m., whereas in summer it drops 2.55 m., it results that at the latter season its maximum depth ought to be 2.60 m., and by far the greater part of the marsh ought then to be dry, for it is of course only those parts that are free from reeds which possess a depth of 2.60 m. Wherever there are reeds, and this applies to nine-tenths of the entire area of the marsh, the depth at the high-water period falls a long way short of that figure, indeed it seldom amounts to as much as 2 m. As the areas free from reeds are the only parts of the marsh that are accessible for sounding, and as all my measurements refer to such parts, it may safely be said that the figure 5.15 m. comes at any rate very near to the actual maximum depth. Thus in the height of the summer it is only an extremely small fraction of the entire area of the marsh that is under water; in fact it is only the deepest trenches and hollows that then contain water. During that period however the kamisch suffers no harm, for it is only left dry for about a couple of months; and not only is the ground-water close to the surface, but the soil itself on which it grows is so thoroughly moist, that the reeds easily hold out until October, when the returning water once more supplies sustenance to its roots. But during this interval, in which the surface is laid dry, will not the wind carry away some of the material from the exposed area, and thus help to deepen the basin, and so tend to preserve it as a depression? Not at all, certainly not. The kamisch prevents it from doing so; for equally whether it grows on dry land or in water, the kamisch still continues to arrest the dust and drift-sand. Add to this, that for some time even after it is exposed, the bottom of the marsh remains moist, and so still detains the loose material. The most important point of all is however this, that in July, August, and September there is but little wind; the season of storms is then past. Hence the annual exposure of certain parts of the bottom of the marsh cannot in any way contribute to the perpetuation of the depression as such.

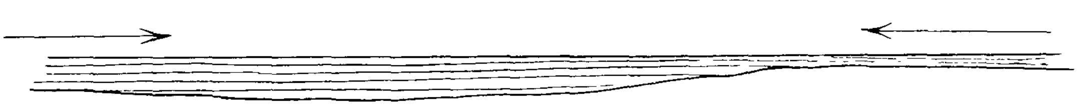


Fig. 107. THE LOWERMOST TARIM ACTING AS A RESERVOIR FOR THE SUMMER WATER.

All the same, and notwithstanding the unanimous statements with regard to the enormous drop in the summer, I truly believe that the Kara-koschun, even at that season, acts upon the lowermost Tarim after the manner of an «aspirator», or suction-pump, although its power is very slight. On the 25th June 1900 the Kum-tschapghan arm was practically dry, for it contained nothing more than an insignificant rivulet. Now a drop of 2.55 m. in the Jurt-tschapghan could not fail to produce a pretty considerable effect upon the whole of the lower deltaic region. The Kum-tschapghan arm, which on 10th April had a maximum depth of 1.99 m., dries up entirely. So also do all the large canals which issue through the left bank of the Tarim, and of which the deepest gave a sounding of 1.08 m.; and the same thing is true of the deltaic arms on the right of the river. The only one that continues to carry water is the Tusun-tschapghan arm, which on 10th April had a depth of 4.80 m., though this diminishes in summer to a maximum depth of 2.25 m. Consequently the whole of the volume that then flows down the Tarim, and it is manifestly a minimum, probably not more than half a score cubic meters, must of necessity, apart altogether from any evaporation and infiltration into the ground, make its way undiminished through the Tusun arm into the Kara-koschun, though, as I have already hinted, it is nothing like powerful enough to fill its extensive marsh, and thus preserve it.

Hence not only is the volume of the Tarim subject to great oscillations in one and the same year, being at the time when the ice melts upwards of ten times as large as in late summer, but it exhibits likewise another species of periodicity, in that some years it has a much more copious supply of water than it has in others. The latter periodicity is dependent upon the weather in the border mountain-ranges. It is evident, that a winter which brings but little snow in the mountains, followed by an especially cloudy and cold summer, will result in a small amount of water flowing down to the lowlands and the deepest part of the basin, whereas with a snowy winter in the mountains, followed by a bright, warm summer, the reverse is the case. These circumstances appear to have prevailed in 1900 and 1901.

On 21st April 1896 I obtained at Kuntschekan Bek's Abdal, that is some distance below Jurt-tschapghan, a volume of 60.72 cub.m. It is of course possible, that some canal or other between Jurt-tschapghan and Abdal may have drained the river to a certain extent, and something also must be set down to the 8 days' difference in point of time, as well as to the different methods of measurement employed; still the principal reason why the river in 1896 had a volume 25 cub.m. less than it had in 1900 is that on the whole the supply of water in the former year was less than in the latter. In both cases I have the spring-flood in mind; the winter precipitation is of no moment, it is the degree of cold in the winter that is the determining factor. The colder it is in the regions through which the Tarim flows, the greater the masses of water that are arrested and held up through the winter in the form of ice, and when this breaks up and thaws, it is clear that the volume of the spring-flood at Jurt-tschapghan, as well as at other points, stands in direct proportion to the coldness of the winter. In this respect however the variations in this the most »continental» climate on earth cannot well be particularly great; still a difference of a couple of degrees may be fraught with important and far-reaching consequences. Besides, it was generally agreed that the winter of 1899—1900 was an exeptionally cold winter; and I myself noted an absolute minimum of — 32,2° C. as compared with an absolute minimum of — 20.8° C. in 1895—96. When the winter is less cold, the ice is not so thick, and larger quantities of water continue to flow down under the ice all the cold season, and the spring-flood is consequently less. Nevertheless the natives at Jurt-tschapghan asserted, that the flood in April 1900 was about half a meter lower than in the same month of 1899, a circumstance which they attributed to the formation of the new arm, the Tokus-tarim, which starts in the district east of Schirge-tschapghan.

My last opportunity of observing the hydrographical relations at the mouth of the Tarim occurred in the spring of 1901. On 3rd April I measured the river at precisely the same place at which I measured it on 25th June 1900. The imposing dimensions to which the river swelled that year are shown in the accompanying section (fig. 108). The breadth amounted to 44.6 m., the mean depth to 3.809 m., the mean velocity to 0.8303 m. in the second, and the volume to 141.05 cub.m. in the second, this being the biggest volume I ever obtained in the lower part of the Tarim system. It was, I have no doubt, the maximum of the season which happened at that precise date to approach the region of the embouchure, while in consequence of the very severe winter the volume was *per se* exceptionally large. That was the spring when the left bank of the river, together with our old winterquarters at Jangi-köl, was washed away by the flood.

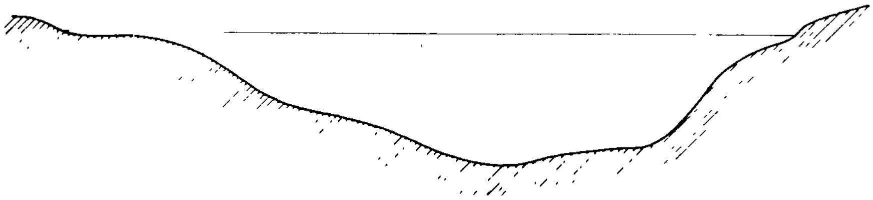


Fig. 108.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Right. | 0.24 | 1.09 | 3.85 | 4.75 | 6.14 | 7.32 | 6.50 | 6.10 | 2.10 | = depth. Left. |
| | 0 | 8 | 70 | 89 | 92 | 91 | 90 | 86 | 62 | velocity. |
| | | 9 | 70 | 88 | 139 | 104 | 104 | 105 | 57 | |
| | | | 51 | 82 | 129 | 100 | 96 | 101 | 61 | |
| | | | 58 | 74 | 90 | 95 | 93 | 103 | | |

Breadth = 44.6 m. Tarim at Jurt-tschapghan, April 3. Scale 1 : 460.

Just as I have above compared the two measurements taken on 13th April and 25th June 1900, so in like manner I may now compare the measurement of 13th April 1900 with the measurement of 3rd April 1901. The volume on the former occasion was 85.91 cub.m., on the latter occasion 141.05 cub.m., or 55.14 cub.m. the larger. The difference may be in part accounted for by the fact that the water-supply in the latter year was in general more abundant than in the former, but also, and to a yet greater extent, by the difference of time, for on 13th April the main body of the spring-flood had already gone past, whereas on 3rd April in the following year I caught it just in the act of passing Jurt-tschapghan. And no doubt during the ensuing ten days, from the 3rd to the 13th, the volume would again have decreased every day until by the latter date it had shrunk to the same value that it had on 13th April of the year before (1900). From the great volume of 1901 we are not therefore warranted in inferring that the river was about to abandon the bed of the Schirge-tschapghan, for this also would no doubt show an increase proportional to that of the Tarim as a consequence of the ten day's difference of time.

On 4th April 1901 I made yet another measurement of the river in its actual mouth at pretty nearly the same place as on 10th April 1900. Here at Kum-tschapghan the main stream gave the following dimensions: breadth, 29.6 m.; mean depth, 2.573 m.; mean velocity, 0.3078 m.; and volume, 23.45 cub.m. in the second. The measurement of the Tusun-tschapghan arm gave the following results: breadth, 22.8 m.; mean depth, 1.772 m.; mean velocity, 0.3975 m.; and volume, 16.06 cub.m. in the second. The Kum-tschapghan arm yielded the following data: breadth, 24.8 m.; mean depth, 1.040 m.; mean velocity, 0.3760 m.; and volume, 9.70 cub.m. in the second. On this, as on the former occasion, there was a difference between the volume of the main undivided stream and the added volumes of its two arms; we will therefore take, as before, the mean value of 24.6 cub.m. as representing the real volume.

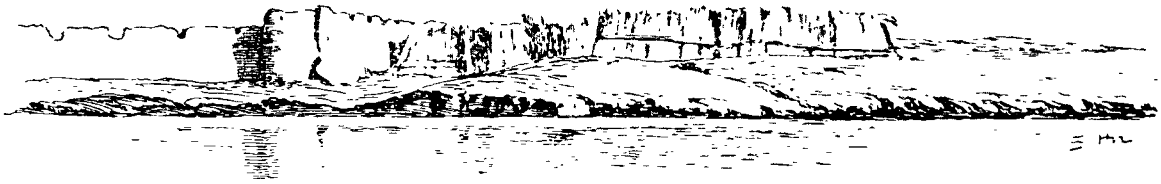


Fig. 109. THE CHINESE FORT OF JURT-TSCHAPGHAN.

Seeing now that the volume of the Tarim at Jurt-tschapghan was, as I have already said, 55 cub.m. greater than at the same place in the preceding year, one would naturally expect to find a corresponding difference in the two terminal arms. In the case of the main river we compared the measurement of 13th April 1900 (at Jurt-tschapghan) with the measurement of 3rd April 1901. In the case of the deltaic arms we have to compare measurements made on the 10th April 1900 and the 4th April 1901. If the high water passed Jurt-tschapghan on the 3rd April, it would almost to a dead certainty pass Kum-tschapghan on the 4th April. In point of fact however the relations at the actual mouth are very different from those at Jurt-tschapghan. On the 10th April 1900 the Tarim at Kum-tschapghan carried a volume of 26.24 cub.m., and on 10th April 1901 at the same point a volume of 23.45 cub.m., or some 3 cub.m. less, although at Jurt-tschapghan the volume was 55 cub.m. more in the latter than in the former year. Thus in the year 1901 the river lost along the short stretch between Jurt and Kum a volume of no less than 117 cub.m.; or in other words, only one-sixth of the actual volume reached the true mouth of the river in the Kara-koschun. In 1900 the quantity which reached the same point was one-third. The 117 cub. m. entered the marsh through other canals, and by other, newer ways. And why? Simply because the old ones are getting choked up, and their banks and ramparts are too high; even those parts of the marsh which they formerly fed with water are likewise getting filled and choked up. Hence the water seeks out fresh paths for itself and finds other depressions to fill, and this exclusively on the north side of Prschevalskij's Kara-koschun. Nevertheless it may be accepted, that the relations of the river, even in the middle of April 1901, after the high water had passed, and the level had dropped, were similar to those of the year 1900. In the light of my observation and experience we may lay down the following law: at the high-water period, the main part of the volume overflows the banks of the lower Tarim above its real embouchure, and a relatively small proportion of the whole goes past Kum-tschapghan. When the river drops, the amount that overflows is diminished, but that which flows on past Kum-tschapghan continues unchanged. As the river goes on subsiding, the several side-canals dry up one after the other. When, finally, the level has dropped so low that none of the side-canals any longer carries water, all the rest of the volume of the Tarim flows through the deltaic arms of the Kum-tschapghan and the Tusun-tschapghan. And it is not until this stage is reached that the river at this place also begins to fall steadily.

Thus the fact of the Tarim having at Kum-tschapghan a volume 3 cub.m. less in 1901 than in 1900 can only be accounted for by changes in the river-bed and in the parts of the marsh immediately adjacent. If these basins go on filling up at the same rate and in the same way, it will probably not be long before both deltaic arms are entirely destroyed. The best proof that this is the correct interpretation of the hydrographical changes which are taking place is afforded by the fact, that the river at Kum-tschapghan on 21st April 1896 carried a volume of 50.2 cub.m. in the second, or more than double as much as in 1901, although the measurement was taken half a month later, when the river was steadily and constantly falling, and at Abdal had not more than 60.7 cub.m. The following table shows the measurements made in the Tarim and Kum-tschapghan in the three years in question: —

| Year | Breadth | Maximum depth | Velocity | Volume |
|---|---|---|---|---|
| 1896 21st April . . . . . . . . . | 30.02 | 6.80 | 0.30 | 50.22 |
| 1900 10th April . . . . . . . . . | 30.00 | 5.09 | 0.3363 | 26.24 |
| 1901 4th April . . . . . . . . . | 29.60 | 4.65 | 0.3078 | 23.45 |

From this it is clear, that with a practically constant breadth, both volume and maximum depth (as also mean depth) decrease. The decrease in the maximum depth suggests as an obvious implicate a distinct proof that the river-bed is gradually filling up.

The same fluctuations and annual changes which are everywhere taking place in this unstable hydrographical system manifest themselves also in the principal deltaic arms, the Kum-tschapghan and the Tusun-tschapghan. In 1896 the latter had a volume of 22.6 cub.m., and the former of 27.6 cub.m. At *that time* the left branch was therefore the bigger, although the migration of the Kara-koschun northwards (described in the following pages) had not yet begun. The situation in 1900 and 1901 respectively is shown in the following table: —

| | | Breadth | Mean depth | Mean velocity | Area | Volume |
|---|---|---|---|---|---|---|
| Tusun-tschapghan | 10th April 1900 | 22.0 m. | 2.364 m. | 0.3729 m. | 52 sq.m. | 19 39 cub.m. |
| | 4th April 1901 | 22.8 » | 1.772 » | 0.3975 » | 40.41 » | 16.06 » |
| Kum-tschapghan | 10th April 1900 | 22.6 » | 1.243 » | 0.3055 » | 28.09 » | 8.58 » |
| | 4th April 1901 | 24.8 » | 1.040 » | 0.3760 » | 25.79 | 9.70 » |

Thus in the short space of 4 years by far the greatest part of the volume had shifted over into the right deltaic arm. But the table appears to indicate that a return to the former condition of things has just begun. In 1900 the proportion which the volume of the Tusun-tschapghan bore to the volume of the Kum-tschapghan was as 2.26 to 1; in 1901 as 1.65 to 1. And while the former stream diminished by 3 cub.m., the latter increased by 1 cub.m. Just as the whole of the lower Tarim swings like a pendulum to and fro across the Desert of Lop, so too do these deltaic arms oscillate, although with a much shorter period. Plotted out on a map, the lowermost Tarim and its deltaic arms present the appearance of a tree, the main river being the stem, its arms the branches, and its lakes the crown of the tree. It is an »inland» delta, and in configuration is just as changeable and as capricious as a coastal delta. The measurements quoted above prove that the deltaic arms are travelling backwards up the river, whereas the lakes, as we shall see presently, are migrating towards the north.

# CHAPTER XII.

## A NEWLY DISCOVERED LAKE NORTH OF KARA-KOSCHUN. — EASTERN AND SOUTHERN SHORES OF KARA-KOSCHUN.

I will now leave the neighbourhood of the mouth of the Tarim, and return to the region north of Kara-koschun which in 1900 and 1901 belonged immediately to its hydrographical system. Here again I will stick to the chronological order, for that method is best calculated to bring out the changes which are taking place in the lake-basin.

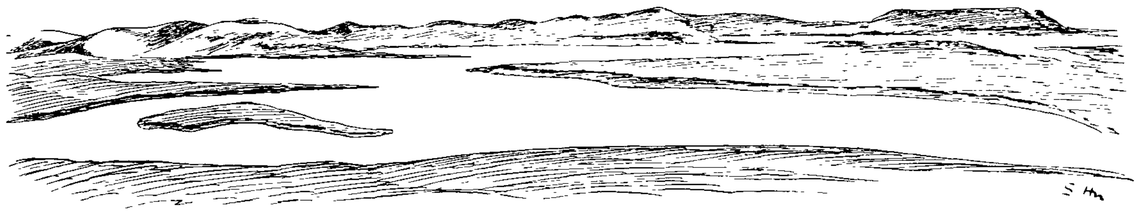


Fig. 110. VIEW TO THE EAST, APRIL 1ST: PART OF THE NEW LAKE NORTH OF KARA-KOSCHUN.

After our first visit to Altmisch-bulak we crossed the desert in a south-south-west direction, and on 1st April 1900 reached the shore of a desert lake: at which I was amazed, for we were still 20 km. from the Kara-koschun. But the appearance of the new lake soon showed that it could not be identical with that marsh. Except for two or three tamarisks, its soft and slightly shelving shore was completely sterile, though farther on there were a score or so of small kamisch stalks. Apart from this, the landscape was quite as desolate as the Desert of Lop to the north of it. The water we thus encountered appeared to have come there quite recently, one or two years earlier. The jardangs and dunes had precisely the same shape and appearance as those in the desert south of the Kuruk-darja; but it was they which for the most part determined the extension and contour of the lake. In several places the smaller dunes were already attacked by the water, so that on its first appearance in this part of the desert it must have been possessed of no slight degree of velocity. The outline of the shore was extremely irregular and zigzag, and the lake contained an abundance of creeks, sounds, bays ramifying in every direction, as well as islets and holms, consisting generally of dunes rising more or less directly from the water. A sheet of water exhibiting such capricious outlines could only originate in a desert that lies on the whole horizontal, has its surface at the same time furrowed into grooves by the erosive action of the wind, and possesses jardangs, or clay ridges, and terraces, as also dunes. The water was perfectly clear and slightly salt, though both camels and horses drank it with enjoyment. Here were no traces of Algæ or molluscs, though we did see one small solitary fish, which, having been brought against its will by the current, would seek in vain for sustenance in that barren basin.

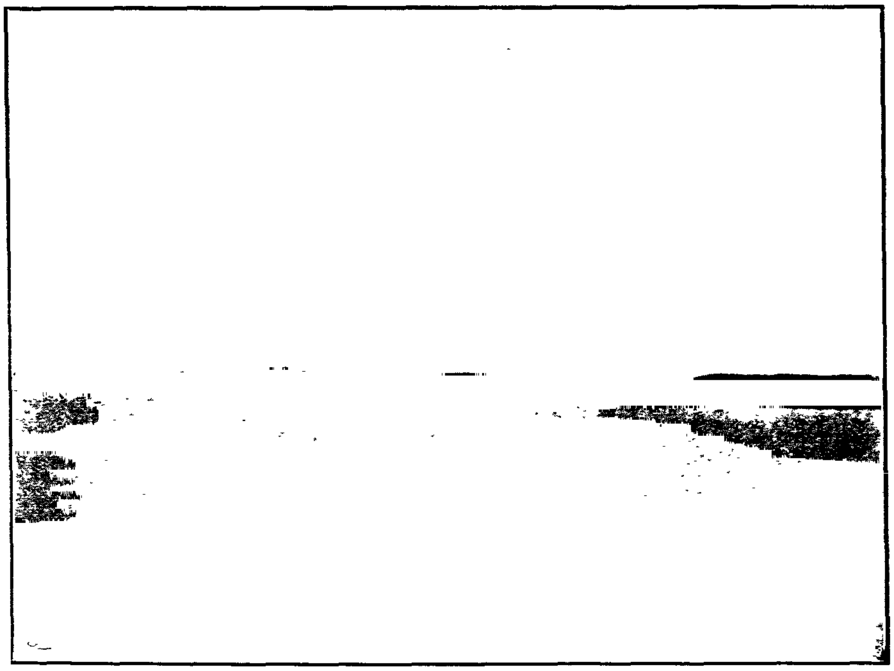


Fig. 111. PART OF THE NEW LAKE TO THE NORTH OF KARA-KOSCHUN (1900).

So far as we were able to see, the point where we struck this lake was at its northernmost bay or projecting finger. Thence a pretty extensive sheet of water stretched to the east, disappearing from sight behind the dunes, which probably screened yet other and more distant expanses. We thereupon followed along the zigzagging shore, seeking for a place where we might get across, for we were anxious to reach the pasture-grounds of Kara-koschun as soon as possible. For half a kilometer the shore ran to the south-west in an almost straight line, and here the lake contracted to such an extent that it was more like an insignificant canal, being only a few meters broad. It was plain, that the water had found here a connected groove, scooped in the surface by the wind. This narrow sound issued into a larger basin, with a solitary tamarisk standing on its shore amongst a few scattered kamisch stalks. The water in this basin was rather fresher. Our course was determined by the contours of the shore, and accordingly we now inclined to the west-south-west. On the left we had basins of varying size, and on our right dunes with their steep sides turned towards the south-west. There were dunes also on the southern shore of the lake. The actual strip of moist shore was so soft that we had to exercise the utmost care when stepping upon it: sometimes the soil, which consisted of clay and dust, literally undulated like waves under the weight of the camels, and in some places there was great risk of their perishing in the ooze. In this way we approached a large lake which extended towards the north-east, and compelled us to make a detour round it before we could continue our westward march. On our left we still had the lake proper, and on our right a number of small detached pools and ponds. The country thereabouts was again perfectly barren, although in two or three places we perceived traces of hares and foxes. At last we discovered a very narrow place beside some tamarisks about a foot high, and there we succeeded in effecting a crossing, for the lake had hitherto shown no break whatever in its continuity. The depth was as much as 90 cm. at the most, and the bottom consisted of dune-sand, firm enough to bear the weight of our camels. From this point the water still continued to extend to the west, though in that direction the dunes were higher. The water-lines, small ridges, and salt rings on the shore proved that the lake had dropped more than half a meter quite recently. The strip of strand thus exposed was still very wet; besides, the lake sent out several ramifications, creeks and hollows, which had likewise been left dry quite recently.

The first impression that these sheets of water made upon me was, that they came from the above-mentioned river-branch which goes off at Schirge-tschapghan (Tokus-tarim); for as this branch is situated to the north of the lowest Tarim, it was only likely that its terminal lakes also would be situated to the north of the Kara-koschun. True, a few days later we crossed over an arm of the river which delivered into the Kara-koschun a volume of 3.5 cub.m. in the second (see p. 127); this, we assumed, was the continuation of the Jangi-jer (Tokus-tarim), and the desert lakes in question might owe their existence to a more northerly arm of the same stream. That the water had only recently come there was perfectly clear; otherwise, stationary as it was, it would have possessed a higher degree of salinity than was actually the case. Further, the vegetation, at all events the kamisch, which is easily transported and spreads quickly, would have established itself on the shores; but in point of fact we saw no kamisch except a few stalks in one or two places. Hence not only the absence of vegetation, but also the slight degree of salinity possessed by the water, were clear indications of the recent origin of the lake. The same conclusion was also pointed to by the position of the dunes. Both on the north and on the south of the lake, nay often in the very middle of the lake, they were grouped in the same way as the other dunes in the same locality. Had the lake been in existence a long time, the dunes on the southern shore would have advanced away from the water's edge, while those which rose like islands out of the water would have disappeared.

With the few data that I then had at my command, it was impossible to solve the problem as to where the water came from. It was only the excursions which I describe below that cleared up this point: the lake had no connection whatever with the Tokus-tarim arm, but was fed directly from the Kara-koschun in the south, and consequently was a northern extension of that marsh.

As for the contour of the new lake, its various creeks, bays, sounds, and other divisions were in almost every case drawn out from north-east to south-west, as one would naturally expect from the conformation of the surface prevailing throughout the Desert of Lop, where the north-east wind plays such a predominant role. When the water begins to invade a region of that character, it is self-evident that its first endeavour will be to fill all the depressions and hollows which pre-exist there.

The strip of desert which intervened between the newly discovered lake and the northern shore of Kara-koschun was 21 km. broad; this we crossed southwards on the 2nd April. Only a few minutes after turning our backs upon the lake, we were once more travelling amongst dunes of the ordinary character. The only sheet of water we saw was in the east, but it soon disappeared. At first the sand increased gradually in height, rising from 7 or 8 m. to 11 m., and in some places it was continuous; though at intervals there were depressions free from sand, corresponding to the bajirs of the Desert of Tschertschen, except that they extended from north-west to south-east and from north-north-west to south-south-east. Clay terraces and jardangs still continued to crop up amongst the dunes, as in the interior of the Desert of Lop, and were nearly always crowned on the top with a clump of old and dead kamisch-stubble, which appeared to be very much younger than that we saw beside the Kuruk-darja and on the northern shore of Lop-nor. Occasionally we came across a piece of withered tamarisk wood. Mollusc shells, which were absent north of the lake, became once more plentiful. Here I picked up a piece of green granite about 2 dm. in diameter, which no doubt came from the mountains that rose nearest to us on the south. In some of the larger bajirs I measured dunes with an altitude of 11 m. and of an exceptionally regular scutiform shape. Small cylinders of sand and lime formed originally round old kamisch-stalks lay scattered about the level floors of these depressions, and intermingled with them were numerous sharp-edged crystals of gypsum. South of these depressions the aspect of the country changed again rather suddenly: the dunes became lower, the tamarisks grew on mounds, which stood closer together, and a little distance off were the trunks of dead poplars still standing upright, making a belt from east-north-east to west-south-west, and concentrating into thicker clumps here and there. These toghraks had been deprived of water whilst still comparatively young; and there were only a few specimens of a more mature and vigorous age. In their existing condition they were a good deal like the poplars of the Kuruk-darja, although in point of fact they were no doubt younger than these. I crossed a similar belt of dead forest immediately south of the bed of the Tokus-tarim at Jangi-jer. It can hardly admit of doubt that these two strips of forest were connected, and formed parts of one and the same long narrow belt of dead forest, running parallel to the lowermost Tarim and the western part of the Kara-koschun; and in the following year I ascertained that it did not extend any farther to the north-east than just this particular spot. It would almost look as if this strip of forest once ran along the northern shore of the Kara-koschun itself; in that case it would bespeak a rather great age for that lake. Such a conclusion would however be a hasty one: for this strip of forest has nothing whatever to do with the Kara-koschun and the Tarim. If it had, it would have followed the shore-line, which, as a consequence of the uninterrupted shrinkage of the lake-basin, has steadily advanced southwards. The information which the Lopliks have to give agrees in an unambiguous way with the actual circumstances. The Lopliks say, that this long strip of dead poplars, often broken and irregular though it is, stood formerly on the banks of the Schirge-tschapghan arm, through which the Tarim at one time poured its entire flood, and beside the Lake of Utschu-köl, of the existence of which Pjevtsoff also learned something. In his book already quoted he says (p. 307), »In the far distant past, when the Jarkent-darja (Tarim) emptied itself into the lake of Utschu-köl, 7 versts north of its present mouth, there was no connection of any kind between the lakes of Kara-buran and Lop-nor (i. e. Kara-koschun). They were separated by a belt of dry ground at least 40 versts in breadth, and each lake was fed by a different river, the Lop-nor by the Jarkent-darja and the Kara-buran by the Tschertschen-darja. According to tradition, the Jarkent-darja in the space of four years carved a path for itself southwards to the Kara-buran, and from this lake there issued soon afterwards an arm which joined the adjacent lakes, whereupon the Utschu-köl, began to dwindle, until finally it dried up altogether. Traces of its basin still remain.»

It was therefore through the existing Tokus-tarim that the Tarim formerly emptied its water into the Utschu-köl. The actual position of this lake is however somewhat doubtful, though it is probable that it, or a part of it, was situated where Pjevtsoff supposes it to have been. The poplar forest we are discussing grew on its southern shore, and it is very likely that the lakes which were formed to the north of the Kara-koschun in 1900 and 1901 coincide with the basin formerly occupied by the Utschu-köl. However that may be, it is certain that these old poplars were associated with a former lake which has now disappeared, and not with the existing Kara-koschun. If this latter were the case, we should be able to find at least one small poplar on its present shores, but for such we look in vain. The specimens, 10 and 15 years old, which are found near the lake farther west, came with the water from above. But on the land journeys that I made in the neighbourhood of the lake I never saw the slightest indication of a young toghrak. The strip of toghrak in question is exceedingly sharply defined and narrow. The fact of our not finding here any old river-bed to cross suggests that we were in the basin of the old lake. On the other hand, jardangs of the kind we are familiar with were common everywhere, and had evidently been scooped out by the wind since the Utschu-köl disappeared, so that its disappearance must date a good long time back. The kamisch-stubble was now more abundant; but whether it belonged to the Utschu-köl or to an expansion of the Kara-koschun it would be difficult to say. Here too it stands upon clay terraces seldom more than one meter high: this points to the kamisch being old, so that it can hardly have anything to do with the last-mentioned lake.

The dunes grew lower and lower, and were scattered, with their horns pointing towards the south-west. This sudden decrease in the amount of the sand in the vicinity of the belt of forest is not due to chance, but is a direct consequence of the hindrance placed in the way of the moving sand by the waterways that formerly existed here. During the interval that has elapsed since this region was laid dry, the drift-sand approaching from the north-east has not succeeded in accumulating here to any great extent. The detached dunes which stand quite close to the northern shore of the Kara-koschun are also very small.

Next followed a zone in which tamarisks were growing abundantly. Most of them stand on the level ground, and though a few do show a tendency to mound-building, the pedestals are not more than one foot high. To the south-west of each of these last there is a miniature ridge of sand. These tamarisks, like the Kara-koschun itself, are new-comers in the region; this I infer, not only from their tender age, but also from the absence of mounds, for the older these trees grow, the bigger are the mounds upon which they usually rear themselves. At length we saw to the south, from the top of a terrace-like clay hill, 4 to 5 m. high, the clear, blue surface of the Kara-koschun extending from south-west to east, and covered with fields of yellow kamisch. The clay hill in question was likewise crowned with dead kamisch-stubble. Although it was undoubtedly the highest eminence in the locality, there were several others of lower elevation. Were it not protected, as it were, by a coat-of-mail of kamisch-roots, it would long ago have been levelled down by the wind, which has scooped out the ground beside it. Assuming that this kamisch once stood on the level ground, then it is evident that the surface has been lowered and carried away by the wind to the depth of not less than 4 or 5 meters.

I have already described our next camp (XXI) and the route thence to Kum-tschapghan. I will now give an account of the excursion which we made in March 1901 along a part of the same northern shore from the east to the camp just alluded to.

On that occasion too I had just crossed the Desert of Lop from north to south, from Altmisch-bulak to the Kara-koschun, though by a more easterly line than in 1900. At barely 700 meters from the northern shore of the Kara-koschun, we crossed a distinct shore-line, showing that formerly the marsh was bigger than it is now. Then at about 200 meters from the water's edge we came to a belt of drift-sand, bound together by vegetation, so that the dune-shape is seldom obvious, although the sand is not more than one meter high. Apart from this, schor, which prevails all over the southern part of the Desert of Lop, runs right down to the brink of the water. Close to the water it was wet for a breadth of 10 to 20 meters, and was dotted over with miniature pools. This moist strip indicates that the level had dropped during the winter. We reached the lake on the 17th March, a fortnight or three weeks before the spring flood came down and again filled the whole of its basin. There was kamisch, it is true, in places along the shore, but it was excessively thin and poor. It appeared to be dying, and indeed had died in patches, all that remained being stubble buried under clay and silt. Long stretches of the shore were quite barren, just as desolate as the desert lake of the year before. The reason the kamisch does not thrive here, notwithstanding the copious supply of water, is that the lake, being relatively at a great distance from the river-mouth, is growing salter, owing to the influx from above being less than formerly. All the same, there was kamisch, thick and fairly vigorous, growing out in the lake at a pretty considerable distance from the shore. Besides, there was a sprinkling of köuruk plants amongst the sand, and a few languishing tamarisks, but not a single mound: the incessantly changing waters of that region have successfully militated against their formation. Due south there was a pretty extensive sheet of water, perfectly open, and to judge from the frequent divings of the wild-duck its depth must have been everywhere extremely slight. Along the shore there were many small silt islands and holms projecting but slightly above the surface. The general impression was that of a veritable marsh. Thus within the short space that intervened between that point, Camp No. CLXVI, and the point where we reached the lake the year before its character was essentially altered. At the former place we found bare, but well-developed, dunes, standing singly; at the latter only one insignificant ridge of sand. At the latter there was an abundance of fresh kamisch; at the former the shore was practically destitute of vegetation. At the latter, the water was fresh; at the former it was so salt as to be undrinkable, except in case of absolute necessity (sp. gr., 1.0052). Hence it may be inferred, that the Kara-koschun, the shore of which here extended west-south-west, could not be prolonged particularly far towards the east-north-east or north-east, and that the region in which these waters finally terminated must be excessively desolate. Still the unexpected sterility of the lake-shore may simply be due to the fact to which I have already alluded, that the Kara-koschun is migrating northwards, pouring vast quantities of water over what was formerly dry land, whilst the central parts of the marsh are becoming entirely overgrown with kamisch. If this supposition is correct, and everything speaks in favour of it, the northern shore *cannot but be barren*, for the water is travelling northwards across the schor desert, and that is of course inherently of absolute barrenness. Hence the kamisch which grew on the older northern shore, now farther to the south, is at this time entirely surrounded by water. It is impossible to trace out and disentangle the changes which the Kara-koschun has undergone in respect of expansion, shape, and position in the part of the Desert of Lop in which it is now situated: not only have the periodic alternations been far too many, but they have obliterated one another's traces. In the vicinity of Camp No. CLXVI we can at all events point with certainty to three different positions of the northern shore — (1) the above-mentioned scarped terrace, north of the existing lake; (2) the shore-line where the kamisch is, and which is to be found somewhere farther south; and (3) the present shore-line, which itself changes at different periods of the year, according as the lake-level rises and falls. Hence it has moved from north to south, and then back again from south to north.

Unfortunately I was prevented from carrying out a portion of my work, and had to abandon some excursions I had planned from this camp, in consequence of an exceptionally violent storm from the east-north-east, which lasted for 55 hours, and immediately after its onset blew with a velocity of 11.5 m. in the second, and soon grew to twice that rate. Shortly before the storm burst, the sky in the east-north-east shot a murky yellow gleam across the desert, but was lighter above the continuation of the lake, from which we may infer that the marsh is prolonged to a pretty considerable distance in that direction. Although the northern shore is accompanied by one insignificant belt of sand, and that is in part held together by vegetation, the storm nevertheless brought with it considerable quantities of drift-sand. Yet very little of it appeared to be arrested there: most of it continued onwards towards the west-south-west and the south-west. The drift-sand is loaded with salt, except where it is pure salt dust that the wind sweeps before it. Whenever my tongue touched my lips, I felt them decidedly salt. A cup of tea, though inside the tent, soon became undrinkable if left uncovered. Nor is it surprising that the wind should carry salt with it. In former times the Kara-koschun unquestionably extended very much farther to the north-east than it does now, and was broader; and large portions of that former inundated area are now dry land. It would of course be the remotest parts of the lake-basin that would contain salt water: hence the ground there is »saturated» with salt, and this under the incessant planing and eroding energy of the wind becomes pulverised, and is then caught up and swept south-west by the storms.

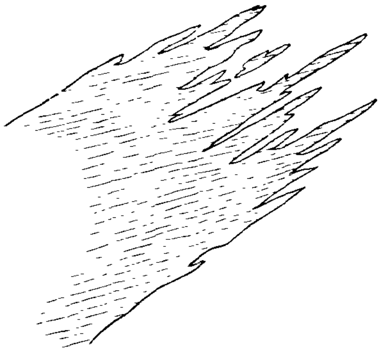
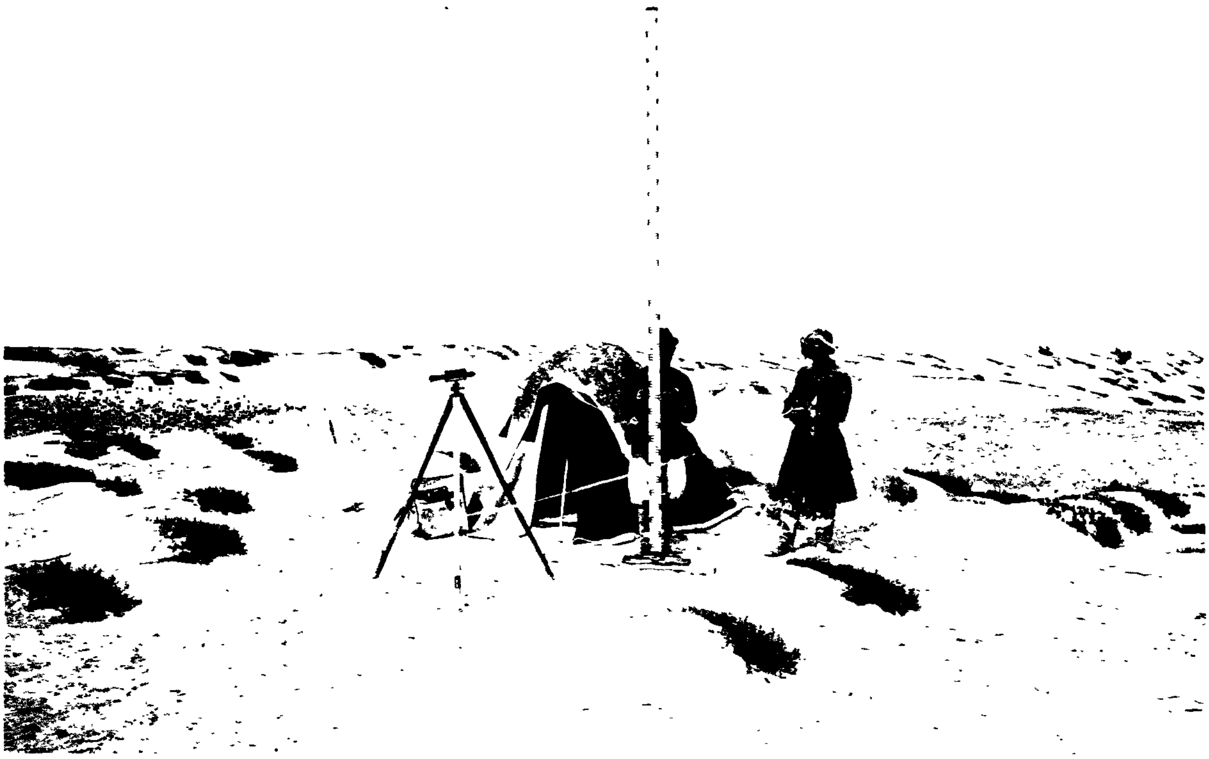


Fig. 112. PROBAPLE CONTURE OF THE NORTH-EAST OF KARA-KOSCHUN.

If we consider that the long axis of the Kara-koschun stretches from S. 60° W. to N. 60° E., and thus lies parallel to the direction of the prevailing wind in that region, we are confronted by the natural question, whether the wind does not by its own direct pressure exert some influence upon the configuration of the lake. It is however impossible to answer this question without seeing the north-eastern extremity of the lake: still I will venture to make the observation, that that extremity will exhibit something like the configuration shown herewith (fig. 112). That is to say, it will send out a number of more or less elongated »fingers» towards the north-east, in the same manner as the desert lake does that lies north-east of the Kara-koschun. The wind will strike that part of the shore at right angles, and drive the firm material before it in parallel strips. The enormous effective pressure which the wind must exercise upon the surface of the water will cause it to be depressed in the north-east, with a resulting elevation towards the west. Here however, in the west, the water likewise meets the resistance caused by the influx from the river; consequently the lake is forced to expand sideways, preferably towards the north, where the surface is virtually level. The lake-basin must be shallower in the north-east than in the south-west, for it is in the former quarter that any dust and drift-sand that the wind carries with it is likely to be in part deposited. Seeing then that the wind is busy filling up the lake-basin from the north-east, and that the river-silt is filling it from the south-west, and seeing moreover that the central parts of the lake are choked with kamisch, the shape which is given to the Kara-koschun on our maps is *a priori* extremely improbable; at any rate I found that the actual shape in 1901 was very different. In fact, the lake is considerably broader and considerably shorter than the maps make it out to be.

It would have been in the highest degree desirable, as well as interesting, to circumambulate the lake on the east and the south, but unfortunately I was unable to do so then. I did however send out one of my men to make a short reconnaissance. He was a Loplik, and the little information he was able to bring me was quite reliable. He returned after the lapse of $5^{1}/_{2}$ hours, so that he presumably went about 11 km. at the most, and in a direction north-east and east-

WESTERN SHORE OF NEW DESERT LAKE NORTH OF KARA-KOSCHUN CAMP CLXVI.



*Ljustr. A. B. Lagrelius & Westphal.*

AFTER FINISH OF LEVELLING OF DESERT ON NORTHERN SHORE OF KARA-KOSCHUN

Drift-sand may be observed accumulated on west-south-west, the sheltered side, of every patch of scrub

north-east. The lake reached as far as he went, stretching N. 53° E. He found two huts amongst the tamarisks in two different places. Just beyond the last of these he observed a *kara-dung* or »black hill», presumably a clay eminence with dead kamisch on it. From its top he saw the lake still stretching onwards in the same direction; but as the atmosphere was thick with dust, he was unable to see more than a couple of hundred meters. At that point however the lake appeared to be a good deal narrower than it was over against our camp, and my Loplik fancied that it swung away to the east and south-east. The shore was accompanied all the way by the belt of low sand, bound with vegetation, but except for that it consisted of barren schor. He saw no kamisch however, either on the shore or in the lake; though in two places he noticed dead kamisch beaten down by the wind, like that on a cape at our camp, where it lay almost horizontal, pointing towards the south-west. Besides this, the kamisch at our camp was so heavily charged with dust and silt that you could walk upon it: it was like a moving quagmire above the pools underneath.

The reconnaissance yielded no positive result, and I am still in uncertainty as to the north-eastward extension of the Kara-koschun. Anyway Prschevalskij's and Pjevtsoff's idea, that the lake is on the whole 90 versts long, is not very far from the truth. What Kosloff, the only traveller who has followed the southern shore of the Kara-koschun, thinks about it will appear from the subjoined extract from his pamphlet on *Lop-nor* (p. 34). »Below the village of Abdal the Tarim divides into three branches, which form several lakes, big and small, amongst the tall reeds. The direction in which not only these streams, but also the entire body of water, extend is from south-west to north-east. Both the northern arm and the southern are 60 versts long; between them winds the third, the middle arm, which comes to an end after a course of 85 versts, being the very remotest artery of the Tarim. As soon as the water stops, the vegetation also very soon stops as well. In the vicinity are broad marshes (schor), stretching north-east for a distance of 300 versts, and these are the extreme tentacles of the Lop-nor. On the north this salt morass is bordered by the sandy desert, and on the south by the sandy desert of Kum-tagh, which has however no connection whatever with the former desert.»

I have already pointed out the improbability of this account.* If it be taken literally, its statement is tantamount to an absurdity, for according to it the salt marsh which forms the extreme north-eastward continuation of the Kara-koschun (410 km. from the mouth of the Tarim) must be the lake of Toli at the southern foot of the Tschöl-tagh; i. e. the old salt depression of the Lop-nor is made to extend right across the whole of the Kuruk-tagh system. If we measure off the 410 km., the distance he gives, towards the east-north-east, as he probably means us to do instead of to the north-east, then his *solontschakis*, or »salt morasses», will reach as far as the lake of Chala-tschi (Chara-nor). Kosloff travelled along their southern shores from Abdal to Chala-tschi. But it is evident, that these salt-marshes can have nothing to do with the Kara-koschun in its recent stadium, because the six altitudes which are shown on the general map that accompanies Roborovskij's and Kosloff's work are considerably higher than the altitude at which they put the Kara-koschun. The well of Tschindejlik, close to the lake, is shown as lying 10 m. above it. My survey of the Desert of Lop indicates that Lôu-lan lies only $2^{1}/_{3}$ m. above the level of the Kara-koschun. Hence a rise in the lake of only 3 m. would practically inundate the whole of the Desert of Lop to the north. But according to the map in question Tschindejlik would still lie high and dry; and the altitudes go on increasing towards the east-north-east. Koschalansa is put at 150 feet above the Kara-koschun, and farther on an unnamed well at 250 feet, while Chala-tschi is placed at 3500 feet, whereas the altitude of the Kara-koschun is 2.600 feet. This makes Chala-tschi have about the same altitude as Schah-jar, Ak-su, Kara-schahr, Boghuluk (on the Tschertschen-darja), Kara-dung (the old town on the Kerija-darja), and Altmisch-bulak. In his later book of travel Kosloff does not consider that the Kara-koschun extends all the way to Chala-tschi, but only to Toghrak-bulak, 142 versts west of Sa-tscheo. With regard to this he says (p. 110). From the district of Latschin the road leaves the shore of Lop-nor, and runs along the southern edge of the belt of salt morasses, beside the old high shore of the lake very nearly as far as Toghrak-bulak. Between Toghrak-bulak and Sa-tscheo the valley gradually rises, forming a direct continuation of the valley of the river Sulej-che.

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* See *Petermanns Mitteilungen*, Ergzhft. 131, p. 144.

But Toghrak-bulak itself will lie on a higher level than the Kara-koschun, and Kosloff, in assuming that the old shores of the Lop-nor reached to that point, carries us back to the distant epoch when almost the half of East Turkestan, and the parts of the Desert of Gobi which lie to the east of it, were under water. Putting aside the depressions north of the Tschöl-tagh, there is not, throughout the whole of Central Asia, any region outside the Kara-koschun which lies so low as the depression of Lôu-lan, south of Altmisch-bulak. I shall however return to this interesting problem in a subsequent chapter.

Here, as bearing upon the question of how far the Kara-koschun extends towards the east-north-east, it may be expedient to quote an extract from Kosloff's journey.

»For a distance of 70 versts, or a journey of three days, we travelled towards the east and north-east, along the southern shore of the lake Lop-nor. For almost the whole of this distance we were accompanied at close quarters by an open (reed-free) belt of water, in some places wide, in others narrow. In proportion as the water grew less the kamisch rapidly thinned, until near the district of Latschin the water came to an end, its struggle with the desert was over. The vegetation of the middle arm of the lake extended farther towards the north-east, until it became lost in the salt morass.»

In the district of Latschin we turned away from the Lop-nor. Immediately south of the lake was a salt plain (schor), its surface crumpled with ridges like »petrified» waves; although we were close to the water's edge we found a strip of soft level ground, on which we were able to march with comfort. The zone of salt is 10 versts or more broad, and is backed by hills on the south; to the east it died away on the horizon. Here we advanced without keeping to any track, until we came to a belt of shore-terraces, superimposed upon the saliferous clay soil and stretching from south-west to north-east parallel to the shore of the Lop-nor, their height varying from 10 to 40 feet. South of this belt of hills comes a stony swelling, strewn with gravel, and beyond it rises the chain of the Altin-tagh. Parallel to it lies the detached ridge of the Takija-tagh, the northern slope of which was strewn with sand, the western border of the Kum-tagh . . . Our route led us along the old shore of the Lop-nor, which changes distinctly from the district of Tschindejlik. Here the stony swelling descends steeply towards the belt of salt desert. The clay terraces attain altitudes of 70 to 100 m., and more. The foot of these terraces and the beginning of the salt desert are the only parts of the desert that are at all tolerable; for here we have a zone of vegetation. In places there are pools with salt water.

»With the view of avoiding the windings of the shore, we did the next stage from Tschindejlik (44 versts) across the continuous moist saline soil. In the middle of the day's march, at a point where the shore recedes a long distance to the south, it would have been easy to imagine oneself at sea . . . . .»

»Between the district of Korot-bulak on the west and Atschik-kuduk on the east, a distance of 150 versts, the desert presents a different character. The salt morass comes to an end, and between the Kuruk-tagh and the sandy masses of the Kum-tagh its place is taken by a broad valley, clothed with the same vegetation that is peculiar to the shores of the Lop-nor. On the north the valley in question is shut in by the steep terraces which run below the border-range of the Kuruk-tagh. Similar terraces border it also in places on the south. In the district of Atschik-kuduk, to which in all probability the east end of Lop-nor (a bay of the same) extends, the valley contracts to a width of 10 versts . . . Its bottom is strewn with rather coarse sand, though farther west it becomes finer and finer, until finally it ceases. To judge from the depth of the wells here, the ground-water is struck at one saschen below* the surface.

From this description we obtain some idea of the desolate desert region which stretches south right away from the shore of the Kara-koschun. With regard to these characteristic terraces of Kosloff, which he considers to be the shore-lines of the ancient Lop-nor, I shall have occasion to describe them more in detail in a later chapter, for I crossed over them along the meridian of Atschik-kuduk. The data of altitude which I have cited above prove best that they have nothing whatever to do with the historic lake of Lop-nor.

Of the three arms into which, according to Kosloff, the lowermost Tarim divides, and of which the middle one is declared to extend farthest towards the north-east, I have only been able to discover two, apart from the numberless arms which leave the river above Kum-tschapghan. It is quite true, that the east-north-east prolongation of the Kara-koschun does consist of a valley, or rather a depression, namely that in which runs the road from Abdal to Sa-tscheo; but when he goes on to say, that it is bordered on both sides by sandy desert, his statement is only correct when applied to the southern side, where lie the sandy masses of the Kum-tagh.** North of this depression and its salt marshes there is no sandy desert, but only schor and clay desert, as I ascertained when crossing the Desert of Lop the second time. The relative levels in this long-drawn-out depression are doubtless such that, were the Bulundsir-gol sufficiently full, its water would flow without hindrance down either to the existing Kara-koschun or to the northern, now dry, depression of the Lop-nor. But to say, that the »old Lop-nor» — in any case a very indefinite term — reached in the form of a bay as far as the Atschik-kuduk, is, as I shall prove later on when I come to discuss the levels of the Desert of Lop, an altogether meaningless statement.

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* *Trudij Eksp. Imp. Russ. Geogr. Ob. po Tsentralnoj Asij 1893—95*, vol. ii. pp. 99 ff.

** I have never heard this name used beside the Kara-koschun or anywhere else in that region. But as it was introduced by Prschevalskij, it may be retained, especially as it is at any rate a distinctive term.

With the view of completing my description of the southern shore of the Kara-koschun, I will now adduce what I learnt from a man of Abdal, who had several times journeyed between that town and Sa-tscheo on the *astin-jol* or *tschöl-jol*, and who also accompanied Kosloff. At first, he said, he kept along the south shore of the marsh until he came to Kurgek, situated on the same shore, where fresh water was obtained from the lake; there was also grazing there, but not fuel. The ground is saliferous, and at intervals there are mounds. Southwards there is no sand. The second station is called Partscha-schor, also on the shore of the marsh, and it had grazing and a sprinkling of young tamarisks. At the time of low water the lake is salt, but it becomes fresh when the high water pours into it. Latschin too is on the shore of the marsh; the district there is *jaman-schorlik*, that is strongly impregnated with salt, and there are layers of salt in the soil. In the autumn the high water is said not to get so far as that place, because it spreads so slowly over the marsh that it freezes before it reaches Latschin. On the other hand the spring high-water (*mus-suji*), which has no such enemy as the frost to contend against, does get all the way to Latschin. This place is said to be situated on the continuation line of the glen of Hunglughu in the Astin-tagh, but no stream ever reaches it from that quarter, not even after violent rains. The fourth station Tschindejlik, is a saline spring, or more correctly two, situated at the foot of a terrace, where the ground is schor. There are jardangs there; and kamisch and tamarisks grow round the springs. Between the last two stations there is some sand. The view north from Tschindejlik embraces nothing but hard, dry schor, which injures the feet of both horses and asses; but there is no trace of either water or kamisch.

Whilst travelling from Kara-koschun to Tatlik-bulak I crossed over this belt of schor, and noticed the fact to which Kosloff calls attention, namely that there is no fuel. He says »the traveller must carry a supply of fuel with him, for the first days out (i. e. from Abdal) there is none to be found. In view of this it is difficult to understand what Littledale means by the following description of his first camp on the southern shore, going from Abdal, »There are distinct evidences of the swamp having been at one time much larger than it is at present, and judging from the number of the roots, there must have been a considerable forest where there is now nothing but arid desert.»*

Along the line by which I crossed the southern belt of shore I did not find even *one* root of any sort. There are few regions in the centre of Asia which are less likely to suggest the former presence of forest than the southern shore of the Kara-koschun. Hence Littledale's vanished »considerable forest« is a puzzle to me. Why should he suspect that there was a forest here just in the very place where there exists nothing at all indicative of such a thing? Kosloff actually advises the traveller along that route to carry fuel with him. Prschevalskij says, with regard to the district south of the lake, Leaving Atschi-bulak we travelled at first 10 versts to the southern shore of Lop-nor, and then 27 versts along that shore (to Abdal). It was a horrid region, a bare salt plain, with irregularities on its surface resembling petrified waves. In the district we crossed there was a similar belt, which was formerly a part of the lake-bottom; there it was 10 versts broad, though farther east no doubt considerably broader. On Lop-nor itself there still remained a continuous ice-sheet more than one foot thick. The belt of pure, reed-free water, now frozen, which extended along the southern shore of this lake, and which in 1877 was 1 to 3 versts broad, had now contracted to less than one-half, a consequence of the general shrinkage in the volume of the Lop-nor».

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* *Geographical Journal*, vol. iii. no. 6 (1894).

Prschevalskij is the only traveller who has enjoyed the opportunity of studying, after an interval as long as eight years, the southern shore of Kara-koschun, and noting how it is travelling to the north, though this is not to be ascribed exclusively to the steady shrinkage in volume, but is also due to an equal extent to the bodily movement of the lake-basin in the same direction. The belt of old lake-bottom, 10 versts wide, was certainly exposed in the years immediately preceding, that is since 1850. In the period 1877 to 1885 the southern shore of the lake travelled yet ½ to 1½ versts farther north. It is evident it would be idle to look for traces of forest in a strip of shore so recently exposed as this, especially as the lake itself along that side is open and barren.

Finally I will quote yet one more passage from Pjevtsoff: all that he learnt about the lake of Kara-koschun agrees almost to the minutest detail with my own observations. He says that the lake »at the present time consists of an extensive sheet of water, overgrown for the most part with dense and exceptionally tall reeds, reaching in places as much as 4 saschen (8.5 m.), and more than one inch in thickness. The lake is oval in shape, and stretches fully 100 versts from south-west to north-east, and runs to 40 versts in breadth. Kuntschekan Bek, who rode all round the lake, told me that it took him exactly five days, travelling every day about 50 versts. According to his calculation therefore the circumference of the lake measures about 250 versts. From what he also said, the lake is encircled by immense expanses of hard broken saliferous ground, perfectly barren, and strewn occasionally with mollusc shells. It was extremely hard work riding across this irregular hardened surface; in fact it was only possible on the very verge of the reed-grown places, for there the ground was a good deal softer as well as leveller. But his search for a suitable site for a dwelling was entirely in vain: there was none to be formed anywhere all round the shores.«*

So long as this same journey has not been performed by any European we must content ourselves with the old bek's account, and this is in my opinion all the more trustworthy, because it agrees perfectly with my own observations so far as I have travelled round the same lake. Pjevtsoff learned that every year the Kara-koschun grows shallower; indeed so much is this the case that the older men remember well how, when they were young, the lake was both very much greater and had more extensive reaches of open water. As to how far the lake stretches northwards, to this question I shall return in the chapters dealing with the Desert of Lop.

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* *Trudij* etc., p. 304. Also quoted in *Petermanns Mitteilungen*, Ergänzhft. 131, p. 132.

The conclusions which admit of being drawn from the above information with regard to the eastern and southern shores of the Kara-koschun are as follows.

(1) The water in the eastern parts of the lake are salt, the percentage of salinity increasing from west to east. The western half on the other hand is perfectly fresh, with the possible exception of small basins temporarily and in part cut off from the main body of the lake.

(2) The shore at the eastern end of the lake, as well as the whole extent of the southern shore, is almost entirely barren.

(3) All round the lake there is a belt of shore which was under water not very long ago. This is narrowest on the south, where the ascent to the foot of the Astin-tagh begins at only a short distance from the lake; and is broadest on the north. To the north-east and east-north-east it cannot be particularly broad; for, according to the altitudes given by Kosloff, the contour rises considerably in that direction.

(4) The zone that was formerly under water consists of schor, that is sedimentary saliferous silt, which, after hardening, has cracked and formed ridges, crevices, and other irregularities of surface.

(5) The actual basin now filled by the lake is itself so flat that the greatest measured depth amounts only to 5.15 m., and at medium level the recently exposed parts of the basin are only very slightly higher, 2 m. at the most, than the existing surface.

(6) Reeds appear to be absent in the extreme east of the lake; at all events, it may safely be said that in proportion as the salinity increases the reeds diminish.

(7) The Kara-koschun has a length, according to Prschevalskij of 90 versts, according to Pjevtsoff of 100 versts. The Sa-tscheo road leaves the lake shore at Latschin, which Kosloff puts at 56½ versts from Kum-tschapghan.*

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* On sheet 62 of *Stielers Hand-Atlas* the Kara-koschun is represented as stretching to the well of Tuja, a distance of 274½ versts according to Kosloff's itinerary, so that it is made three times longer than it ought to be. The mistake is due to Kosloff's description, which has also been used for the map of the Russian general staff (*Karta Juschnoj Pogranitschnoj Polosij Asiatskoj Rossij*). On the latter we find the altitude 2,550 feet at the embouchure of the Tarim into the Kara-koschun, but a long way out into the marsh the altitude is put at 2,720 feet. But Kosloff would appear to have modified subsequently the views which he urged in *Lop-nor*, for on the general map which accompanies his and Roborovskij's work the Kara koschun is given a length of barely 70 versts; and there is no marsh at all to indicate its north-eastern continuation.

# CHAPTER XIII.

## THE WATERS ON THE NORTH OF THE KARA-KOSCHUN.

After this digression let us return to Camp No. CLXVI on the northern shore of the Kara-koschun. On the 20th March there was a gentle south-south-west wind, the sky was grey and louring, and a rather thick mist prevailed, apparently a blend of water vapour and dust, so that it was not easy to get a comprehensive view of the country around, a thing I was especially anxious to obtain just there. During the night a belt of ice, 1.8 cm. thick, but very narrow, formed close along the shore.

Here the Kara-koschun exhibited an extremely curious outline. One would have expected it to extend, as it did farther west, in a denticulated line towards the south-west; but we discovered that we had encamped on a peninsula, and accordingly had to make a detour north and north-north-east to get round one of the largest, possibly the very largest, open basin I have seen in the Kara-koschun marsh; it was directly connected with the sheet of water beside which we had encamped. The sandy ridge I have mentioned, a belt of dunes one meter high and 20 m. broad, and for the most part bound together by living and dead tamarisks, stretched along the right shore of the new basin. Its very appearance instantly suggested one conclusion. The bushes, which were completely dead and withered, had reached a considerably greater age and maturer development than the living ones, for these last were quite young and small. Thus between the two generations there had intervened a waterless period, during which the lake had withdrawn in one direction or the other; otherwise there was no reason why the tamarisks should die. And it is only since the water has returned that the younger bushes have sprung up.

Thanks to the withered reed-stalks cast up by the waves, and now rotted to a black mass, the shore-line is quite distinct and sharp-drawn, and can be clearly made out 100 m. and more back from the existing shore. Yet the margin of the lake is so flat that even this great distance indicates but a very slight rise. It is very probable however that this shore-line was due to quite recent high-water, possibly that of the preceding autumn, for the strip of ground between it and the existing shore-line was moist, soft, and oozy, and of course absolutely barren. In places there is a sprinkling of mollusc shells, relics of the waterless period alluded to. The lake-basin is shallow, even in the middle, as we could see from the way the wild-duck dived.

I have already stated, that the man whom I sent out to the north-east observed old huts in two places. We now discovered yet a third little fishing-station on the shore, consisting of two small kamisch-huts of the usual character, and situated on the belt of sand itself, and, the sand being just there high, they were buried in it nearly 2 m. deep, up to the eaves in fact. Thus the huts had proved a greater hindrance to the drift-sand than the belt of tamarisks amid which they were built, for amongst these latter the sand was only one meter high. The fact of the belt of sand thus faithfully following the shore, whether that extends south-west or north, has therefore nothing to do with the lake, but is due to the little belt of steppe-plants and tamarisks having arrested the drift-sand.

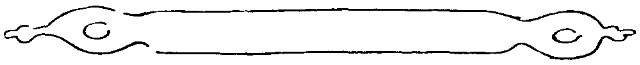


Fig. 113.

Some of the posts belonging to the framework of the huts stuck up out of the sand, and also 75 cm. of the end of a canoe, which was left propped up against one of the huts when they were finally deserted. As the canoe, so far as it projected above the sand, was perfectly free from blemish, I thought I would use it for examining the adjacent parts of the lake, and I therefore had it dug out; but when we had removed about 1.25 m. of the sand, we found that the canoe was split and rotten. The excavation brought to light however a duck carved in wood; a stick with simple ornamentation, such as the natives use to stir their mutton with when boiling in the pot; and a piece of board of the shape shown in fig. 113, which I understand is used in weaving. Of course from these things it would be impossible to infer anything as to the age of the station, for they are precisely like those used in the Lop country at the present day, and were in a good state of preservation, so that they could not be many years old. On the other hand similar objects of wood which I unearthed at Lôu-lan, and which had been buried in the sand for 1600 years, were in an equally good state of preservation. But there are other, rather important, inferences that might be drawn from these finds. Without doubt the village was deserted in 1876—77 when Prschevalskij paid his first visit to the Kara-koschun, and noted down every fishing-station beside and in the lake; this one does not appear in his list. Further, the station and the lake had then almost exactly the same relative positions as now. The huts were only 80 m. from the shore, and everywhere throughout the Lop country you find that the natives prefer to erect their homesteads and villages amongst the sand if they possibly can. Hence the belt of vegetation, and the little belt of sand on which it is growing, were clearly in existence when the huts were built. It is equally evident, that no Lop fishermen would have settled there had there not been good fishing in the lake. Accordingly when these huts

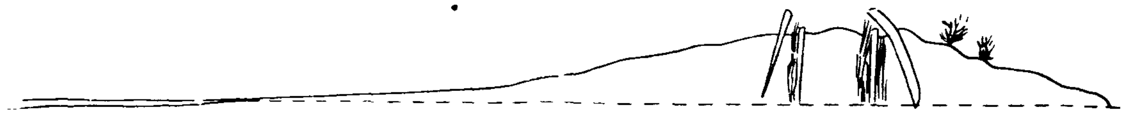
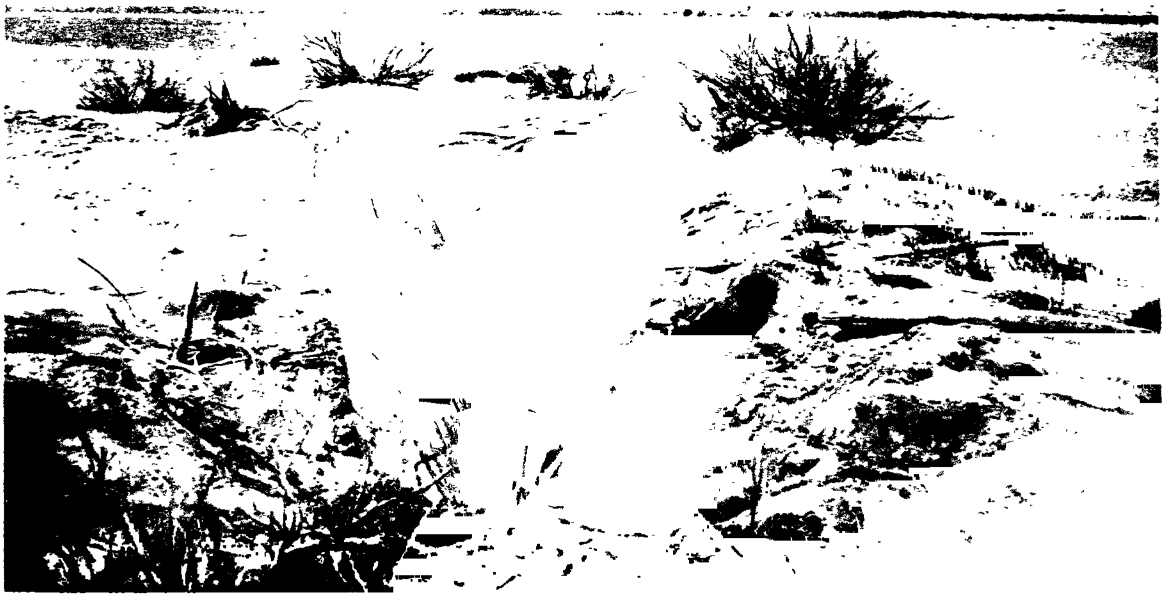


Fig. 114. THE HUTS AT THE PRESENT TIME.

ENTIRELY NEWLY-FORMED DESERT LAKE. MARCH 28TH 1901.

The white patches are froth and bubbles made by water gushing up from below.



*Ljustr. A. B. Lagrelius & Westphal.*

ATTEMPT TO DIG OUT AN OLD SANDED UP CANOE.

In background the great basin of Kara-koshun running north.

were built, the lake-basin was in that part deeper than it is now, and its water perfectly fresh and well stocked with reeds; whereas at the present time there does not exist one reed-stalk, and the water is slightly saline and very shallow. But how far the reeds disappeared during the waterless period, when the tamarisks died, or whether they perished in consequence of the increasing salinity of the water, cannot be decided, though the former is more likely the case. Perhaps it was the advent of the arid period which led to the huts being definitively abandoned, otherwise the natives would have taken their canoe with them, for when it was left behind it was doubtless sound and whole.

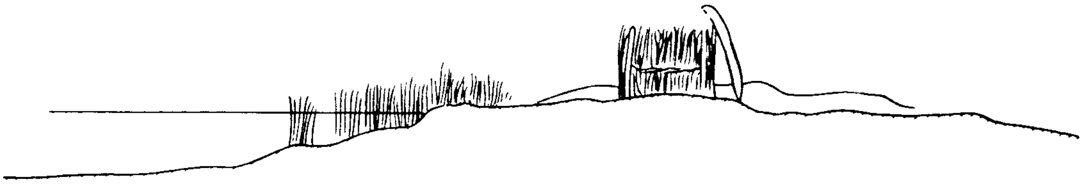


Fig. 115. THE HUTS WHEN STILL INHABITED.

If the lake was formerly deeper, as I have good reason to believe, then it is far more the filling up of the lake than its shrinkage which has in time caused it to grow shallower. This is clearly proved by the fact that the bases of the posts of the framework lie only 1 to 2 dm. above the existing level; in fact the lower end of the canoe was actually a couple of dm. below the existing level, and it is this which caused it to rot. Fig. 114 shows the position at the moment of our discovery, and fig. 115 the condition of things when the huts were still inhabited. The drift-sand and dust have elevated the lake-bottom, but the huts are certainly about the same distance from the shore now as formerly. Another clear indication that this little fishing-station was deserted a pretty long time ago may be seen in the fact that none of my attendants had ever heard speak of them, and still less of the other four huts situated farther to the north-east. The circumstance, that they as well as the village of Kara-koschun (which Prschevalskij after his visit calls Kara-kurtschin) and the village of Ortäng (Ujtun) were deserted one after the other, proves that the lake is undergoing a steady shrinkage and that the population beside it has diminished. The lake is unable to support so large a population as formerly, and many of the inhabitants are already abandoning their old mode of life and devoting themselves to agriculture.

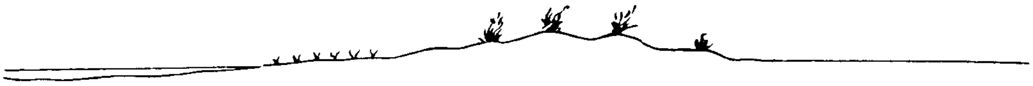


Fig. 116. VERTICAL SECTION OF THE SHORE REGION.

At length we reached the north-east corner of the lake, and could then turn to the west-south-west. Here we observed some low mud-islands, partly overgrown with tamarisks. The shore was exceptionally straight; parallel with it grew a belt of köuruk, and farther away the belt of low sand with its sprinkling of tamarisks again made its appearance. North of that stretches the extensive barren schor desert, as flat as a table top. In that direction there is no sand visible, not even the smallest or most rudimentary dune. Consequently the sand which the storms sweep across the desert from the north-east and east-north-east does not stay here, but is driven on farther. Except for an infinitesimal quantity detained by the belt of vegetation alluded to, the main mass is blown straight out into the lake.

About half-way along the north shore we came upon another hut, divided into two rooms, and built, like the others, on the sand, though this stood almost upon its very surface. Glancing southwards, we might have imagined ourselves on the shore of an oceanic bay: the wide expanse of water disappeared in the mist and of the opposite shore not a vestige was visible.

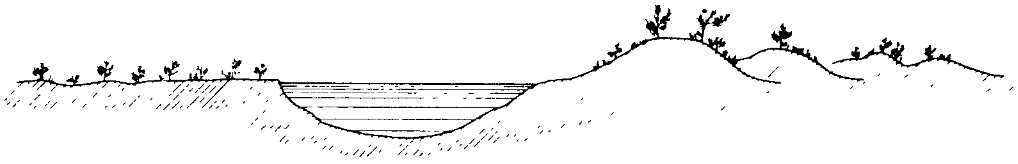


Fig. 117.

Then, crossing over the root of a cape, we came to another smaller lake. On the right we passed a hollow, resembling in shape a very short river-bed, but so deep that the water in it was of a dark green colour; it was clearly very much deeper than the adjacent lake, with which it had recently been in communication, for they were united by a channel one meter broad and half a meter deep, and running N. 10° E., though the connection is now severed. Eventually this lake too came to an end, that is to say it turned off to the south, and we then passed on to a stretch of barren schor desert, and a second depression resembling an old river-bed, deep and full of water, but completely cut off from the lakes. A certain amount of sand had accumulated on its north-east shore, and there the tamarisks were growing on mounds nearly two meters in height (fig. 117). As we proceeded we passed on our left several shallow sheets of water, small lakes and pools, all barren and salt, and there were two or three also on the right. As a rule the ground consisted of hard, rough schor, which seriously hampered our march. We passed several broad, shallow trenches, recently formed by overflow water. This however had not got very far towards the north before it was absorbed by the thirsty ground, which was perfectly dry at only one or two dozen meters from the water-line. Sometimes however, in spots that lay a trifle below the water-level, the moisture showed on the surface as darker patches upon the grey saliferous clay. We pitched Camp No. CLXVII amongst some tamarisks, encircled by low dunes. Judging from the signs we saw there, the locality was frequented by wild-boar, antelopes, foxes, and hares; while wild-duck were numerous, and frequently flew off to the north. In the vicinity we discovered a little lake, whose water had a specific gravity of 1.0058.

On 21st March we discovered another lake-basin immediately south-south-west of our camp, with an abundance of kamisch growing in two of its bays. Tamarisks and other vegetation were more general than they had been, as also traces of game. Along the shore were several small lagoons disconnected from the lake. The country thereabouts appeared to have been recently overflowed. All these scattered sheets of water were incredibly shallow; and a long way out in the lakes tamarisks and other steppe plants were growing, which had been surprised by the sudden inundation. This supposition in no sense militates against the fact, that the first lake, with the huts, retained its shores for a long time, even though it may have been with interruptions, for it is also within the bounds of reasonable supposition to infer that the shallowing of this and other lakes is one of the causes which compel the water to overflow in another direction, and that takes place, as we saw not only here but also during our canoe-trips on the Kara-koschun, towards the north, where the basin is lowest. The large and small sheets of water which we here had on the south, and which extended a long way to the west, were also completely sterile, the reason being that they have spread out over parts of the barren schor desert. Here our farther advance west was stopped by a channel, 2.2 m. broad, with a mean depth of 0.55 m., a velocity of 0.45 m., and a volume of about half a cubic meter in the second. The water, which was almost clear, had a temperature of 9°.4 C., with a distinctly saltish taste. It issued out of a small lake or expansion, and flowed, strange to say, towards the west. It was absolutely impossible for us, even for a man on foot, to wade across this watercourse, for its bottom consisted of soft ooze, into which our longest tent pole readily penetrated without touching firm ground. When I ascertained that this channel came from the north-east, I at once jumped to the conclusion, that the stream had its origin in the desert lakes of the previous year, and

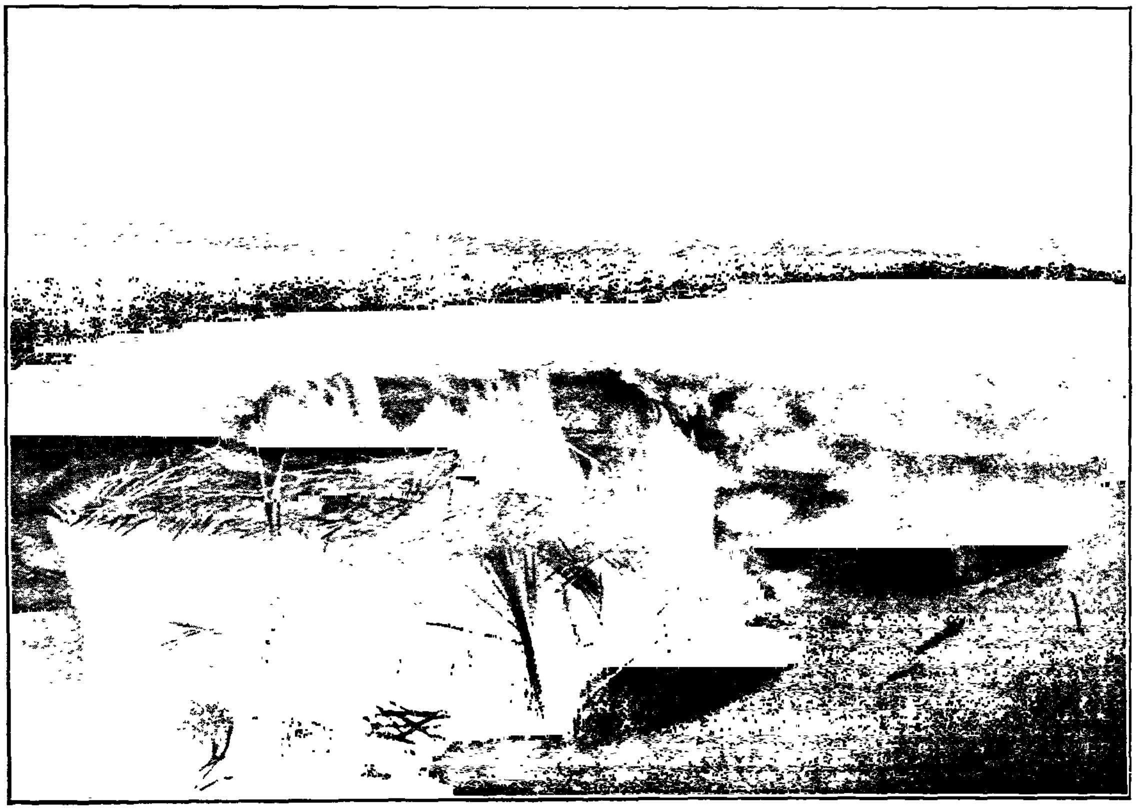


Fig. 118. THE HUT ON THE NORTHERN SHORE OF THE LAKE.

that these in their turn originated in the Tokus-tarim, whose lowermost reaches here found their way into the Kara-koschun. But upon examining the neighbourhood further, we soon found that the hydrographical relations were by no means so simple as that. The stream in question emptied itself into a series of smaller lakes, while from the marsh to the south two arms issued, going west and north-west. Thanks to the tamarisks and steppe-plants which grew in them, their bottoms were firm, and allowed us to cross over them. After that we were able to continue a good distance towards the west, skirting these arms on the south, as well as the small lakes into which they emptied. But we were again soon stopped by another arm flowing towards the north. This we could indeed have crossed had it been necessary, but not very far west of it there was yet another arm bigger than all the others put together, with a volume of fully 4 cub.m. or more. It was about 10 m. broad, had a mean velocity of about 0.5 m., and a mean depth of 0.8 m., all these being autoptic estimates. As it was absolutely impossible for camels to get across this stream, our road was completely barred: we were in a position in which we were surrounded by water on every side — marsh, lakes, pools, and actively flowing currents. Within a very small area the water was thus streaming towards every quarter of the compass, except east and south-east. It was like an orbital movement, a *maelström*, gravitating everywhere towards one centre. During the hour we were detained here whilst a reconnaisance was being made, we actually saw a fresh arm form on the south, and flow slowly, very slowly, across the level schor, which grew darker and wetter as the little tentacle meandered northwards. It was clear, that the greater part of these hesitating streams were destined eventually to make for the north. Here then a fresh overflow was taking place before my very eyes; the Kara-koschun was palpably spreading northwards across the barren desert.

Our next concern was to select a place for our camp where we should not be drowned out during the night, or completely inclosed by fresh streams that might form. Next day we had no choice but to retrace our steps towards the north-east, in order to get out of the treacherous labyrinth. Passing Camp No. CLXVII, we shortly afterwards left our former route to the south and directed our steps to the north-north-east across the schor, which was dotted over with sporadic desert plants and in two or three places had miniature accumulations of sand. At length we reached the continuation of the channel that stopped our way, or rather the chain of small lakes into which it broke up. From Camp No. CLXIX we could see very extensive sheets of water to the west. Clearly there was nothing for it: we must make a detour round these newly formed parts of the Kara-koschun. We discovered later, that it would have been a shorter road, had we gone round the Kara-koschun east and south instead of following the crooked path we did pursue. But we were more than recompensed for our toilsome march by the discoveries we made, discoveries which confirmed the idea I threw out in 1896.

On 23rd March the relatively large lake beside which we had encamped soon contracted into a narrower waterway, with thousands of little bays and »sidings«, in which we could distinctly see how the water pressed forward to every low-lying spot in the vicinity, while at the same time every irregularity of the surface that projected in however slight a degree formed a small island or holm. Here and there along the margins of the water young tamarisks a year old were growing up. Their seeds had no doubt been brought there originally by the water, and were now shooting up after being moistened afresh. The köuruk plants had however nothing to do with the water, for they were dotted about at a considerable distance from it. As compared with this quarter, the eastern part of the Desert of Lop which we had just crossed was a perfectly sterile region.

For a considerable distance we travelled north-east beside this irregular sheet of water. In the narrower passages it moved with a pretty lively current, and even in the expansions its movement was distinctly perceptible. In the channel which had stopped our progress, the flow was towards the south; here it was towards the north-east. Along the line on which I surveyed the desert, we had ascertained during the last few days that there was a slight fall southwards; but here, not especially far west of that line, the slope was towards the north-east. That is to say, the level of the Kara-koschun was at that time somewhat higher than the portion of the desert that lay to the north of it.

At length we came to an absolutely barren neighbourhood. The last lake with the schor islands sent off a small emissary, only 15 to 20 m. long, and that issued into yet another lake, which in its turn extended north-east. Thus one shallow depression after the other was being filled: as soon as the water lipped the edge of the threshold on the north-east, it broke over, formed a new canal-arm, and sought out a fresh basin to fill; and in this way this narrow offshoot from the Kara-koschun kept pushing farther and farther towards the north-east.

The canal had a breadth of 7.2 m., a mean depth of 0.32 m., and a mean velocity of 1.02 m. in the second; so that the volume amounted to 2.35 cub.m. in the second, or 203,000 cub.m. in the 24 hours, this being the mass of water that was being drained out of Prschevalskij's Kara-koschun by this one arm alone. This was just the season, and especially a few days later when the water from the melting ice would begin to enter the marsh, that these offshoots would swell and flow away to the north; indeed there was no other way they could go. No doubt the pioneer water that arrives first is used up in moistening the schor ground, and it is not until, dry and thirsty as it is, it has become consolidated, that the channel is able to continue its progress; meanwhile the southern basins of the Kara-koschun go on filling higher and higher. Of course vast quantities of water are lost through evaporation in the dry and barren desert. On the whole the ground here is, so far as one can see, perfectly level schor. But the presence of the little current we were following proved, that even this flat schor region had its irregular surface-furrowings, and that they ran parallel to the jardangs and their intermediate gullies in the northern part of the Desert of Lop. This is also no doubt an effect of the wind; and we found that this same south-west to north-east direction characterised all the offshoots of the western Kara-koschun.

The bottom of the 7.2 m. broad channel consisted here of blue clay, as slippery as ice on the surface, but quite firm enough to bear us, so that we should easily have been able to cross it with camels. The water had washed away the layer of loose schor and was flowing along a bed of firmer material. Over a considerable area north-west of the channel the surface layer was wet, so that when walking across it we sank in 35 cm., until we landed upon the underlying deposit of blue clay. Neither I nor any of my three attendants had the least knowledge of that country, or of the distance to which the lakes extended; and that year (1901) they appeared to be especially active. We should certainly have crossed over this channel and endeavoured to push on west, where we should soon have been stopped again by other new sheets of water, only just at that moment fresh guides arrived from Kum-tschapghan. We now traversed perfectly level, barren schor until we at length reached the distant pool which we had first seen on the 20th March, and which, in opposition to the prevalent law, stretched from south-east to north-west.

Seen from Camp No. CLXX, this sheet of water stretched away to the S. 80° E., but farther on it turned an angle and proceeded S. 50° E. We were unable to see the end of it; but from the wide open expanses of water which appeared to the south and south-east, it was possibly connected with them, or else terminated quite close to them. At our camp the breadth of the stream was 15 m., though lower down it amounted to 30 to 38 m., and to judge from the limpidity of the water, the depth was considerable. The sp. gr. was 1.0033. The tamarisks here, especially on the north-east shore, grew on mounds formed of drift-sand, which they had thus arrested. On the lee shore there were, on the contrary, neither mounds nor sand, though there was indeed an occasional tamarisk standing on the bare ground. On the shores, and especially on the south-west shore, a narrow strip of kamisch was growing. To the south the ground nearest to the pool was overgrown with steppe-plants, and they were in a more thriving condition than anywhere else in this part of the desert.

A glance at Plate 15 will be sufficient to convince the reader that this depression cannot be anything else but a river-bed. In shape it resembles the lower Tarim, down to the minutest details. But it is clearly older than that part of the Tarim which lies between the Kara-buran and the Kara-koschun. What role this stream formerly played it would now hardly be possible to ascertain. Did it form the continuation of the Tarim at the time when the entire volume of the river poured through the Tokus-tarim? In that case it probably formed a link between the Utschu-köl and some other lake to the south of it. Or perhaps this arm discharged the same function, and occupied an equivalent position, to the waterway the right side of which we had lately followed towards the north? The former is the more likely alternative, for the tamarisk-mounds, being so high as they are, indicate that the arm has been in existence a long time, and its shape points, as I have said, to an actual river.

From this spot we travelled on the 26th March mainly north, leaving our former route immediately on our left, and soon came to a large sheet of water, which formed a link in the waterway we followed on the 23rd. During the four days that had elapsed since our new guides first rode that way several fresh expanses of water had formed. One little pool was manifestly quite new; it pointed as usual to the north-east, and was fed by a channel, 3 m. broad, 0.1 m. deep, and flowing with a velocity of 0.55 m. per second. We rode round it, and even whilst our animals were drinking at it, the water advanced so rapidly that their footprints were gradually blotted out.

Pl. 15.

Ljustr. A. B. Lagrelius & Westphal

CAMP CLXX. AN OLD RIVER BED STILL FULL OF WATER, ON NORTHERN SHORE OF KARA-KOSCHUN.

In the course of our farther march to the north we only once touched any offshoot of the western sheets of water. The aspect of the desert now changed. The flat, but rough, schor grew smaller and smaller, while the jardangs, which predominate in the northern half of the desert, became more and more numerous. Low dunes showed here and there, always accompanying dead or living tamarisks. Gullies or furrows were common. Sometimes it was not easy to say whether they were formed by water or by wind, though some of them have plainly once been traversed by water, just as some of the depressions were evidently once small lakes, and very soon they were going to be filled again. In places the bottom was already moist, and some of them contained small pools of water that came bubbling up from below. The water in the lake-basin beside which we encamped was distinctly salt (sp. gr. 1.0066); nor is that surprising, seeing how saliferous is the ground over which this thin sheet of water was spreading. As we had already ascertained that the water of the Kara-koschun grows increasingly salter from south-west to north-east, we likewise ascertained that here in these newly formed lakes the salinity increases from south to north.

At Camp No. CLXXI, and at several other places during the next day's march, the 27th March, we noticed droppings of the wild-camel, proving that this animal does roam as far as the vicinity of the Kara-koschun; there is at all events no risk of its being disturbed by hunters either on the east or on the north of the lake. Indeed the distance between its true habitat along the southern foot of the Kuruk-tagh and these newly formed lakes is not, as the map shows, especially great, and for the wild-camel at any rate it is a mere trifle.

Next day we marched north-east and north-north-east, crossing over innumerable jardangs, some of which, immediately on our right, were crowned with dead toghrak forest and tamarisks still standing upright. On the other hand at Camp No. CLXXI there were numerous green tamarisks on the shore, the roots of which had evidently reached down to the ground-water even before the arrival of the fresh offshoots of the lake, for not only were the bushes pretty well advanced in point of age, but there were no withered ones amongst them.

At length we came to the outermost extremities of these lakes, which point like fingers to the north-east, and in every case follow the already existing gullies between the jardangs, sometimes broken up however into long, narrow pools. From that point there was no water visible to the north, only the clay desert with its countless ridges. We were also able to journey westwards without hindrance. For a distance the tamarisk steppe was unusually thick; and although the bushes were still standing on their own roots, most of them on small elevations, they were without exception withered and dry. Next followed a belt of toghrak forest, pretty thick and still standing upright, but likewise withered. To determine, even approximately, at what epoch the change took place in the distribution of the water is impossible. This belt of vegetation grew either on the north shore of the Kara-koschun when it extended farther north than it does now, or else on the southern shore of the old lake of Lop-nor. It is at any rate situated about midway between the two depressions in question; and had I known that the Kara-koschun had that year begun to migrate towards the north, I might have shortened my desert survey by almost one-half the distance. Still it is only along the line of traverse I chose that the existence of the depressions makes itself evident; at the point of which I am now speaking there is, on the contrary, nothing to prove that we were within the radius of either the one depression or the other. True, the fact of these sheets of water having direct communication with the Kara-koschun would seem to indicate that we were still within *its* basin; but the evidence is only apparent, and ceases to carry weight when we call to mind the effects produced by the wind in bringing about changes of level. Whichever lake the belt of vegetation in question may have grown beside, the elevated shore on which it stood would appear not to have borne that character for any very great length of time, for neither the trees nor the bushes had reached a medium age, but were still young when the water deserted them.

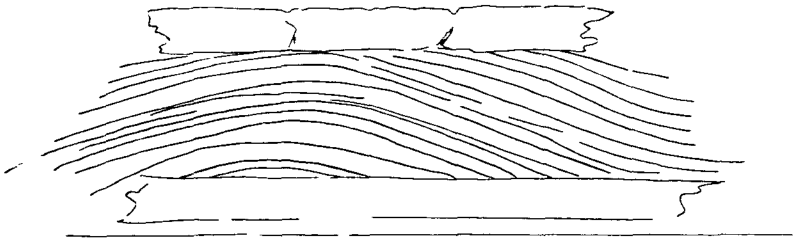


Fig. 119.

Then the dead vegetation decreased again; but there was still no living forest, and it was extremely seldom that we saw so much as a shrivelled bush or a prostrate toghrak stem. At one place on this strip of ancient shore we lighted upon fragments of earthenware. Mollusc shells abounded everywhere, in some places in truly enormous quantities. The bedding of the clay in the wind-sculptured jardangs showed that the sedimentary matter had been laid down at different periods. One instance is depicted in the accompanying fig. (119). On the top there is a layer of hard, compact, yellow clay to a thickness of 3 dm.; beneath that a layer of softer darker clay, 8 dm. thick and distinctly folded; and this is underlain by another layer of the hard yellow clay, disposed horizontally. It is clear that in this flat region, over which the Lop-nor has wandered to and fro for so many centuries, there must exist countless instances of changes of this sort. I suppose that the intermediate folded layer corresponds to the ordinary schor formation, i. e. saliferous clay sediment, which dries into »granulated» ridges and folds after the water has flowed away off it. On the other hand the yellow clay with the perfectly horizontal disposition was laid down in fresh-water lakes, and contains a larger percentage of sand, corresponding to the larger percentage of salt in the schor. And the actual distribution of the clay desert and the schor desert around the present Kara-koschun lends support to this supposition: as the schor desert preponderates more and more towards the north-east, so also does the salinity of the water increase in the same direction.

Here too, where we are now pausing, the jardangs are crowned with clumps of kamisch-stubble, and in one place the stubble was so thick and high that in case of need we might very well have used it as grazing for our camels.

Pl. 16.

Ljustr. A. B. Lagrelius & Westphal

VIEW ACROSS A PART OF NEWLY-FORMED DESERT LAKE BETWEEN KARA-KOSCHUN AND LOP-NOR.

Its shores are absolutely barren. (Looking east from Camp CLXXII.)

As we advanced to the west and south-west, the sand continued to increase in quantity. The dunes were at first small and widely scattered, but soon grew higher, running up to 7 and 8 meters. Here again we had confirmation of the law, that the sand increases in quantity from east to west, and from north to south. Here underneath the sand there were always jardangs; but as we were travelling south-west, they occasioned us no inconvenience. They often stuck out of the sides of the dunes, forming platforms and cornices. In the latter part of the day's march, where the sand lay in an almost unbroken sheet, it was evident that it almost entirely neutralised the effects of erosion upon the substratum. But as the erosion gullies in this part of the clay desert are in every case likewise drawn out from north-east to south-west, it is evident that the wind accomplished its erosive work before the sand was spread out over the desert. This circumstance proves that, after the drying-up of the lake-basin in which the clay deposit was laid down, the bottom of the lake must have been for a long time open and exposed to the wind, before the drift-sand began to accumulate on this side. The depth of the gullies, 2 to 3 m., is a proof that this period of freedom from sand must have been a long one. At the present time, and under the conditions that now prevail, the sand is going on piling itself up in larger and larger quantities in the south-west parts of the Desert of Lop.

Here again we frequently passed pools and sheets of water which had no visible connection with the larger lakes. The water in them came bubbling up from below, and was strongly impregnated with salt.

We pitched Camp No. CLXXII by the side of an offshoot from the lake. The shore of the latter projected towards the west, and there it was quite easy to perceive the flow of the water from the south towards the north-east. Thus there was here a slope in the latter direction, even at such a great distance from the northern bank of the Kara-koschun proper — Prschevalskij's Kara-koschun. Clearly this region corresponds to that part of the surveyed line where we found the surface rising from north to south, the only difference being that, here in the west, there must be a gap or hollow in the threshold (a couple of meters high), which in the east separated the northern depression from the southern depression. The current in the nearest lake, which was most irregular and capricious in outline, showed that the overflow water of the Kara-koschun had not yet reached its most northerly limit, but was still pushing its way on north and north-east. Vast quantities of water are lost in moistening the ground. The little pools I have alluded to are but the skirmishers as it were of the advancing flood, and are soon swallowed up by the expanding lake. The water here had a sp. gr. of 1.0069, and consequently was almost undrinkable; even the camels were content with merely sipping at it. As the day advanced, and it grew warm, the water became actually repugnant; but in the morning, after the coolness of the night, the salinity was less noticeable. The neighbourhood of this camp was perfectly barren; there was not even *kötäk* (dead wood).

On the 28th March we doubled the north-western angle of the new lake; consequently our line of march turned to every quarter of the compass — west, north-west, south, south-east, east, and north-east. At first, after leaving camp, we steered towards the west and north-west, having a number of small lakes on our left, and on our right, that is to the north, dunes without old vegetation. The sand increased perceptibly in quantity. Then we turned to the south-west, and after that once more to the west. A pool, with an area of about 50,000 sq. m., the water of which had a temperature of 14°.2 C. at noon, was, on the evidence of my new guides, a perfectly new creation. It was very interesting to observe the way in which the water here spread and worked its way north. The pool in question was evidently completely isolated and disconnected, for the water which reached it all came up from below; we actually saw it bubbling and boiling up with a loud noise, just as boiling water gurgles in the pot (Pl. 14). In two or three places the upgush was so strong that it formed domed pillars one dm. high, rippling unceasingly, like a miniature geysir. The air which accompanied this upgushing water formed bubbles and rings of froth round each little geysir, and these were drifted by the gentle east wind into the western bays. When I saw similar collections of froth a long way to the east of this position, I did not understand how they could have originated, but attributed them to the last storm which swept across the country. During the time we remained on the shore of this pool — and it was entirely surrounded by drift-sand — we observed the water distinctly rising. Owing to the constant upflow in the middle there was a slow centrifugal movement outwards towards the periphery, and in two or three places, where the shore was flat, small arms or emissaries were being formed, which hastened to empty themselves into the little hollows at the sides. Hence the shape and outline of the newly formed pools were determined by the dunes which stood around them. Strangely enough, the water here was fresher than it was at the two adjacent Camps Nos. CLXXII (sp. gr. = 1.0069) and CLXXIII (sp. gr. = 1.0059), whereas here the sp. gr. was only 1.0036: that is to say to us it was almost perfectly fresh. One would naturally suppose that the water which came boiling up out of the ground would be salter than that which came streaming along the surface. The fact that it was not so proves that the soil just here was not especially salt; indeed it may perhaps be taken as a proof that it had been a fresh-water lake up through the sedimentary deposits of which the water was making its way.

The water was not perfectly clear, and I only found out where the bottom was by sending in a Loplik who could swim, to measure the depth with two of the tent-spars. In the pool there was a jardang, which even then was not in the slightest degree softened by the water. The greatest depth amounted to 2.22 m. I may mention that the whole of this pool, and innumerable others in the course of the day's march were all formed since my two attendants, the Cossack Tschernoff and the Loplik Tokta Achun, son of Kuntschekan Bek, rode past them on their way out to me. Tschernoff had even drawn a sketch-map to show the way they had come; but there was no need of it, the tracks of their horses were quite sufficient. They had travelled diagonally across the pool, for it was at that time dry ground. Now on the way back, they rode straight down into the water on the west side and up out of it again on the opposite or east side. How far the track was continued across the 2.22 m. deep depression could not be determined; it is very possible therefore that seven days before there had likewise been a pool in the bottom of it which the men had forgotten. In another pool, smaller and shallower, they were able to retrace their steps all the way across, although it was now covered with a sheet of water 43 $^1/_2$ cm. deep; so that in this we have a key to the height of the water's rise, equivalent to an average of 6 cm. a day. If the rise was thus considerable at that date, it must of course be very much greater when the ice-water from the Tarim begins to pour into the marsh; then when the summer came, there would be a subsidence, and finally with the autumn high-flood a fresh rise. The circumstances connected with the larger pool suggest certain interesting conclusions. The unceasing bubbling up of the water in the decimeter high miniature geysirs proves that the level of the pool was not yet equal to that of the Kara-koschun. Although the height to which these »geysirs» rose affords no exact indication of the difference of level, they do suggest that it was not at any rate small, seeing that even after the water had overcome the friction of the soil it made its way through, it still possessed so much force as this. When the time comes that the water ceases to boil up in this way, and the level of the pool is equal to that of the southern lakes, then, unless the flow be in the meantime arrested, a considerable part of the desert to the north and north-east will certainly likewise be under water. As for the pool in question, we only know that its bottom lay 2.22 m. below the level of the Kara-koschun plus what was still required to fill it completely. If we assume that it would rise about 0.8 m. higher after the inflow of the ice-water had time to make its presence felt, we should have a total depth of 3 m., a depth to which Prschevalskij's Kara-koschun rarely attains even after the spring-flood, and which is never encountered in its southern part at any season, for the maximum depth I obtained there was only 1.90 m. But we shall not be in a position to appreciate the real significance of these great hydrographical changes until we have analysed the levels of the Lop Desert as a whole. I will however mention *en passant*, that everything goes to prove, that the Kara-koschun is just now in movement again, and there is every probability that still greater changes are in prospect. The recently discovered lake-basin had already covered very nearly half the distance between the Kara-koschun and the northern shore of the old Lop-nor, and there can be no doubt that, provided the supply of water is not in the meantime cut off, it will continue its journey until it reaches the depression in the northern part of the desert. There is nothing in the relative levels to prevent it from doing this; for the bottom of that depression lies lower than the present surface of the Kara-koschun; and the very fact of the water flowing north and north-east is a proof that there is here no threshold such we found along the line of our survey across the desert.

There is however one other factor which undoubtedly had no slight effect upon the changes that were taking place in the spring of 1901, though unfortunately the physico-geographical conditions connected with it cannot be set forth. I mean the precipitation and other meteorological conditions in the border mountain-ranges in the period immediately preceding. I was indeed told that during the summer of 1900 the Chotan-darja, the Jarkent-darja, and the Ak-su-darja had all carried large volumes of water, and that even the Kontsche-darja had risen, though owing to its flowing through the Baghrasch-köl its volume is generally constant. All this was clearly the result of the exceptional quantity of snow that fell in 1899—1900. The winter of 1900—1901 was very cold, and there was an unusual quantity of ice formed throughout the Tarim system. When this melted in the spring, it gave rise to a heavy spring-flood, and although the main body of this did not pass Abdal before the first days of April, it would nevertheless certainly make itself felt in the end of March, even as far from the embouchure of the river as this. I was also told, that the exceptionally violent spring-flood had washed away a long stretch of the left bank of the Tarim, and that the Basch-köl had risen very considerably, and no doubt the same was true also of the other lakes situated in the sand. These statements do not however admit of any sure conclusions being drawn from them, for they emanate from a couple of my Cossacks, who only saw the rivers and lakes on two separate occasions. That the volume of the Tarim does change from year to year is unquestionably true, even though it be within narrower limits than those which apply in the case of rivers that flow to the peripheries of the continents. And as it changes, so also does the volume of the Kara-koschun. But the principal cause why the latter overflowed and made its way north in the spring of 1901 was evidently this, that its own basin is no longer able to hold so much water as it used to do in the past, and consequently the water has to find an outlet in some other direction.

# CHAPTER XIV.

## HYDROGRAPHICAL RELATIONS ON THE NORTH OF THE KARA-KOSCHUN.

After that we continued our westward march across heavy and difficult sand. From the point where we doubled the north-west offshoots of the new lakes, we perceived the sand, high and continuous, stretching west as far as we could see. A little beyond the extreme offshoot running west we passed our Camp No. XX of the year preceding; it was easily recognisable from the marks of the camp-fire and the preserved-food tins which we had left there. This gave me a valuable point of connection with our route of the year before. The problems which at that time confronted me would now soon be all solved. I thought at that time that the water was coming from tke Schirge-tschapghan, but I now ascertained that it was proceeding direct from the Kara-koschun. Had we the year before only gone a very short distance farther west, there would have been no need for us to cross over the canal-arm, and it was now (1901) so swollen that it was out of the question to think of trying to do so. Had we not discovered the traces I have alluded to, it would have been impossible to recognise the neighbourhood again. The distribution of the water was quite different; the pools and basins of the preceding year had swollen and spread out on every side, and run more together, while the expanses of water to the south-east were greater, and the mud and sand islands fewer and farther between. In the west however, and there only, there was no expansion; hence the level in that quarter was rising. The spot on which my tent had stood, a little below the camp-fire, was now covered with water, and it extended right to the foot of the *jar* in the vicinity.

Let us now compare the results of the observations made at this point in 1900, on 2nd April, with those made in 1901, on 28th March, that is to say in both cases alike *before* the ice-water had begun to enter the marsh. We note first that the contours of the surface, in so far as they affected the distribution of the water, were the same at both dates. The new lake extended just as far towards the north-west in 1900 as it did in 1901, its north-west extremity being in both years precisely the same. But there was this difference, that the water in the depressions was higher in 1901 than in 1900, so that what were islands in the latter year were under water in the former. What the conditions were farther east it would be impossible to say, but the chances are that they were the same there as in the west; that is to say, it is very probable that all the lakes which we discovered in 1901, or if you like the one large greatly subdivided lake, was everywhere the same in both years, just as it certainly was at the one point where I had an opportunity to observe it, namely at Camp No. XX. But to the east the lakes were more scattered and less connected in 1900 than they were in 1901.

And upon comparing the conditions at Camp No. XX with those of the Tarim at Jurt-tschapghan, we are at once struck by the great parallelism between them. At the place named, the Tarim had on 13th April 1900 a volume of 85.91 cub.m., and on 3rd April 1901 a volume of 141.05 cub m., in the second. On the 2nd April 1900 the newly formed lakes had a smaller volume than on 28th March 1901. I have already observed that a difference of ten days at this season may make the greatest difference in the volume, and that as soon as the high water has gone past, the river drops very rapidly. If now the high water passed Jurt-tschapghan about the 1st April, one would expect the lakes to be greater on the 2nd April than on the 28th March. As an actual fact the reverse of this took place. This goes to show that the Kara-koschun as a whole, under all circumstances, and apart from the annual fluctuations in the volume of the river, and irrespective too of the date, is shifting towards the north. The large volume of 141 cub.m. was measured on the 3rd April, or six days after my second visit to Camp No. XX. Possibly it had been even greater before that; but at all events on 3rd April it was so large that the new lakes went on swelling and, as we saw with our own eyes, were continuing their migration to the north. Another difference as compared with the year before was, that the water was now (1901) a good deal less salt.

After getting round the corner of the lake, we proceeded to the south-east and east beside the irregular and capricious outlines of the large lakes, and the open and spacious basins, in which there was no vegetation. Here too there were narrow »fingers» stretching between the clay ridges and the drift-sand, all running towards the south-west or west. In one or two places, as well as at Camp No. CLXXIII, there were tamarisks, barely 3 dm. high, which had evidently struck root only one or two years before. We also observed two or three small patches of kamisch, but all put together they would not have been enough to satisfy one camel. There was no kötäk anywhere; but mollusc shells were everywhere abundant. The only birds we saw were gulls and wild-duck.

During the night of the 28th—29th March, or a space of 15 hours in all, the lake rose 5.6 cm., though some portion of the rise ought perhaps to be attributed to the wind from the east-north-east, which blew during that time and attained a velocity of 11.5 m. in the second. We often heard the clay ridges, after being undercut by the vigorous action of the waves, plumping noisily into the water.

After going some distance farther to the east, we turned off to the south-south-west, so that our route was now rather more easterly than it had been the year before; as a consequence of this there was somewhat less sand. After a while we passed an offshoot of yet another pretty large lake-basin, beside which tender young tamarisks were growing, as well as a few stalks of kamisch. Both appeared to be one year, or at the most two years, old. The condition of the vegetation is the best proof that the water had only recently reached that locality; and if it stays, it will not be long before vegetation grows up there as vigorous and as dense as that in the Kara-koschun. The flowing water will carry it into all the northern basins; the plants we already observed were the forerunners of its propagation in that quarter. On the other hand, dead tamarisks, with or without mounds, as also old kamisch-stubble, were now becoming more and more plentiful.

At first the sand was not more than 5 m. high, and as a rule the ground between the dunes consisted of hard clay, with jardangs, but it was increasing, and the dunes had already met in some places. The only localities in which the ground was level and bare was close beside the new lakes, where we were travelling. Although these lakes were only a couple of years old, and in their present size only one year old, the effect they had on the distribution of the sand was evident. As, generally speaking, the lakes make their way from south to north, they put themselves as an insurmountable barrier in the way of the drift-sand coming from north-east and east-north-east. The dunes which stand on the west side of the lake receive no further augmentation, but are diminished and transported onwards by every fresh storm, so that in this way they gradually move away from the lake-side, which soon becomes swept altogether free from sand. If the new lakes go on increasing in size, and spreading farther and farther to the north, as they probably will do, and if they remain long enough stationary, they will in the course of a few decennia totally alter the character of the south-west part of the Desert of Lop in which the dunes now are. These will continue their migration towards the south-west and west-south-west, while the belt of sand-free ground beside the lakes will continue to increase in breadth. Nevertheless the mass of the sand will always advance along the same route as that in which it is now moving, until it comes to the bank of the Tarim and the Tokus-tarim. As for the stream of drift-sand which continues to pour in uninterruptedly from the north-east, it will, even as happened to the Kara-koschun during a long period, help to fill up the new lakes, and then, after they too have become overgrown with kamisch, they will be forced to leave their beds and seek lower depressions elsewhere. It is this incessant circulation, which has unquestionably been going on for thousands of years, that not only has levelled up this part of Central Asia, but also explains how it is that the whole of the Desert of Lop and the region of the Kara-koschun lie virtually at the same level, the difference between the highest and the lowest point not exceeding 8 m. Beside the lake where we discovered the canoe and the huts, we fancied we detected some effort towards providing a natural protection against the drift-sand. The little belt of tamarisks which accompany that lake had, at any rate to some extent, arrested the drift-sand, causing it to form a low rampart, which its roots bind and hold together. But even though this rampart, which will increase in height as time goes on, does arrest a part of the drift-sand, the fate of the new lakes is nevertheless sealed, for large quantities of sand and drifting dust do all the same find their way into them.

During the second half of the day's march we passed the same belt as we did the year before. The sand, after once more increasing in height, suddenly passed over into scattered dunes. Then we crossed the zone of dead tamarisk-forest, where the stems of the bushes were more than one dm. in diameter, and after that made our way through the tamarisks, which now appeared to be fresher and more vigorous than they were a twelvemonth earlier, and finally we crossed over the terrace-like hill from the top of which we had first seen the Kara-koschun a year before. Here the same changes had taken place as at Camp No. XX; that is to say, the nearest »finger» of the lake, pointing south-west, which in 1900 was barely visible in the north-east, had now reached the foot of the hill. Our old Camp No. XXI was still dry land, though surrounded by water, its lake having expanded very considerably. The maximum depth, which in 1900 was 3.70 m., had now in all probability increased a good deal. A year previously the main body of the lake extended to S.85° E.; while a large bay, as we thought, ran north-north-east and disappeared in the distance. It now turned out that it was not a bay, but a broad sound, through which all the water was flowing that was going to form the new lakes to the north.

We pushed on past the lake, and past a couple of its offshoots, without stopping and pitched our tents beside a sort of bay running south-west. The little party of Lopliks, with one of my Cossacks, whom I had appointed to meet me here with fresh provisions, had 22 days earlier erected a hut on a peninsula in what they deemed a perfectly safe place; but the water had risen so seriously that the hut was almost entirely surrounded by it, and was then actually touching it. Camp CLXXIV was so near to Camp CLXVII, that a rifle-shot could be heard from the one to the other. Whilst we rode round, two Lopliks, who took a short cut of a day from the latter camp, had to cross the broad streams which were supplying the northerly lakes with water, and had indeed to traverse the greater part of the distance swimming.

Fortunately we found at this hut two canoes which had been brought from Kum-tschapghan, so that I was now in a position to examine more closely the adjacent parts of the Kara-koschun. Before going on to describe the trips I took on it, I will enumerate the names which the natives gave me as designating the adjacent parts of the lake. They are not indeed fully reliable, at all events those are not which apply to the most easterly lakes, the parts which the Lopliks have not visited for scores of years. That the names exist, and have been in actual use, admits of no doubt; but possibly they may indicate other basins than those which I intended in my inquiries. However, one old man declared, that the lake with the huts and the canoe we found was called Terema-köli, or the Fish-skin Lake, and another to the east of it Tschakirni-aghsi. South of Camp No. CLXVII was the Kurban Kulluni-köli. The lake beside which we had made Camp No. XXI was the Jäti-äräli; the name, meaning the Seven Men, is said to have been given to it because seven fishermen once settled there to monopolise the fishing. Jodak-köl was a lake quite close to us. Mökme-köl was a small lake, plentifully overgrown with kamisch, to the south-west of our camp; while south of the same point was the large lake of Tschajnot-köl. Between this same camp and Camp No. CLXXV I was given the names of the following lakes — Tschöl-köl, Jagh-isma-köl, Kirtschin-köl, Sägislik-köl, Äschäk-kurmatschlik-köl, Jegrenlik-kir. Still farther to the south-west lie the basins which I have already mentioned when describing one of my canoe-trips on the northern part of the Kara-koschun.

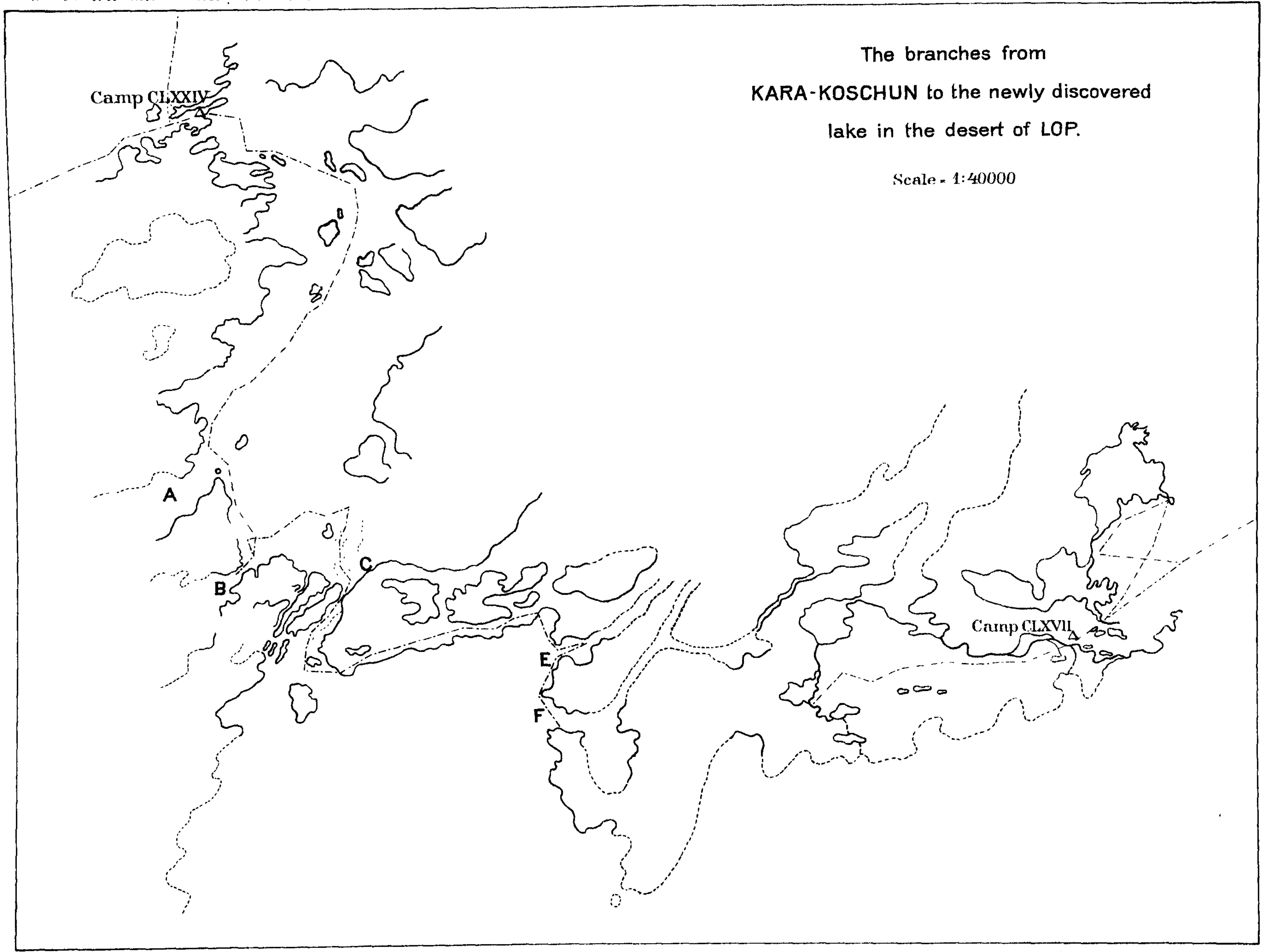
The new desert lakes, as may readily be conceived, had not yet received any names, for the simple reason that there was not a single Loplik, whether fisher-

Pl. 17.

Ljustr. A. B. Lagrelius & Westphal.

LOOKING EAST ACROSS KARA-KOSCHUN FROM CAMP CLXXIV.

The scenery is very characteristic of the Kara-koschun, which is more like a marsh than a lake.



The branches from
KARA-KOSCHUN to the newly discovered
lake in the desert of LOP.

Scale = 1:40000

Fotolit Gen Stab Lit Anst Stockh

man or hunter, who had ever heard speak of them, or had himself seen them. This again goes to prove that they could not be more than two years old. If they remain stationary, and the fresh water, vegetation, fish, wild-duck, and wild-geese visit them, then they will soon acquire names, mostly the names of the men who first settle beside them, or names derived from some trivial circumstance or occurrence connected with their animal or vegetable life.

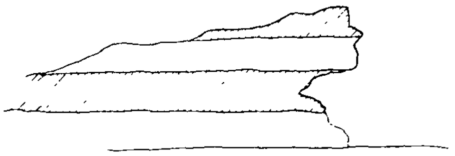


Fig. 120.

The 31st March was given up to a canoe-journey across the sheets of water that supply the northern lakes. First came a number of intricate expanses, more or less amply furnished with kamisch, in which there was almost everywhere a flow towards the north. We travelled east, then south, and finally south-east, doubling a vast number of intricate elbows. Except for the occasional fields of kamisch, the bordering tracts consisted mostly of terraces and ridges of clay, with sometimes sand. Some of the jardangs and tamarisk-mounds were in part cut down and washed away by recent currents. The perpendicular sides of the clay terraces showed alternate dark and light layers, and a closer inspection revealed the fact that the former contained plant remains. It was probably sediment laid down in shallow water in which kamisch was able to grow; while the lighter layers, which are free from traces of vegetation, are indicative of water that was too deep for kamisch to grow in it. Apart from this, it was, as usual in the Kara-koschun, difficult to obtain a clear conception of the direction and outline of the various basins, owing to their shores being so often masked by kamisch. There are an abundance of islands and holms, frequently nothing more than a projecting jardang or a mound with its uplifted tamarisk. On the annexed sketch-map I have traced our itinerary, and all that we saw on both sides of it. The capital letters correspond to the lake arms, the sections of which are discussed in the text. From F we observed the adjacent shore stretching away to the S. 10° E., while the very large expanse of the Tschajnot-köl extended south and south-south-west, this being one of the very largest sheets of open water I have seen anywhere in the whole of the Lop-nor region. The lake of Tschöl-köl was said to lie S. 35° W. from the same point.

In the several lake-basins that we paddled across, we sounded depths of 1.70, 1.97, 2.6, 2.1, 2.8, and 2.7 m. The greatest depth measured in the Tschajnot-köl was 2.75 m. In the arm C the maximum depth was 4.4 m., measured at a place where there was an eddy. All these measurements were taken at spots where the dark shading of the water indicated that the depth was considerable; but on the whole the lakes were very shallow. When you call to mind, that the pool with a maximum depth of 2.22 m., which I have already described, was not yet full, and that the water issued boiling from the bottom and then rose 1 dm. above the then existing level, its real maximum depth must have been almost exactly the same as the mean depth of the lakes I now measured, or 2.37 m., and must have fallen but little short of their maximum depth of 2.75 m., and yet the pool in question is situated almost two days north of the true shore of the Kara-koschun. How very little of a real »depression« is then the region in which the Kara-koschun is situated!

Taking as my guide one of the men who swam across all the actively flowing streams between Camp No. CLXVII and Camp No. CLXXIV, I now travelled along each successive stretch of firm shore, tracing out these waterways one by one. The first of them, the arm A, was very indistinct and shallow; evidences of its recent formation were discernible in the temporary, and but little eroded character of its bed, as well as in the abundance of steppe plants and tamarisks with which it was accompanied. Its breadth amounted to 140 m., its mean depth to 0.695 m., its mean velocity to 0.0321 m. in the second, and its volume to 3.12 cub.m. in the second. The greater part of this insignificant and slowly moving volume flowed through the deeper channel to the east, where the depth was 1.75 m.

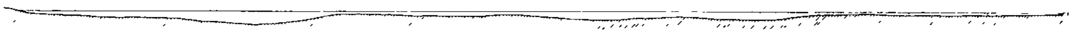


Fig. 121. Right. … Left.

| | Right. | | | | | | | | | | | Left. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| = depth. | 0.72 | 1.01 | 1.75 | 0.35 | 0.74 | 0.38 | 1.13 | 0.75 | 1.06 | 0.31 | 0.42 | 0.42 |
| velocity. | 17 | 9 | 9 | 6 | 10 | 1 | 1 | 1 | 0 | 1 | 0 | 2 |
| | 1 | 10 | 3 | | 0 | 0 | 1 | 2 | 3 | 1 | 0 | 1 |
| | | 5 | 1 | | 1 | | 0 | 1 | 1 | | | |

Breadth = 140.0 m. Branch A, March 31. Scale 1 : 1000.

The arm B bore a closer resemblance to a river-bed, because in it the erosion was farther advanced. Its breadth was 19.5 m., its mean depth 0.696 m., its mean velocity 0.3243 m., and its volume 4.40 cub.m. in the second. Its right bank, like the left bank of arm A, consisted of clay ridges, with tamarisk-mounds.

But arm C was the first that afforded distinct indications of being a real, decisively excavated river-bed. Its breadth amounted to 9.8 m., its mean depth to 1.588 m., its mean velocity to 0.5572 m., and its volume to 8.67 cub.m. These measurements were taken where it was narrowest, its general breadth in other parts being two or three times greater. On emerging from the Tschajnot-köl its waters gather into a broad channel, and by a similar broad channel it discharges into the lake-basins to the north.

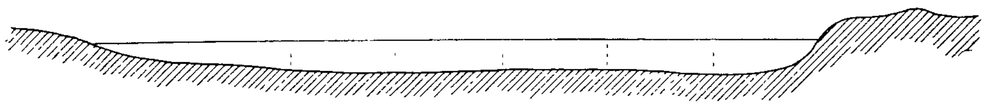


Fig. 122. Left. … Right.

| | Left. | | | | | Right. |
|---|---|---|---|---|---|---|
| = depth. | 0.69 | 0.80 | 0.84 | 0.79 | 0.78 | 0.97 |
| velocity. | 34 | 60 | 68 | 44 | 48 | 7 |
| | 35 | 60 | 64 | 40 | 50 | 7 |
| | 17 | 36 | 41 | 10 | 20 | 0 |

Breadth = 19.5 m. Branch B, March 31. Scale 1 : 200.

Then follow two small arms, partly hidden in the reeds, partly subdivided into a number of shallow, winding channels. Judging by the eye, I estimated their volume at about one cub.m. each.

Arm E was 50.1 m. broad, 0.744 m. in mean depth, 0.1913 m. in mean velocity, and had a volume of 7.13 cub.m. in the second.

The dimensions of arm F were as follows — breadth, 68.0 m.; mean depth, 0.415 m.; mean velocity, 0.0680 m.; and volume, 1.92 cub.m.

Hence these five arms, together with the two arms D, had altogether a volume of 27.24 cub.m. in the second. All are extremely short, and owing to the recent date at which they broke through the intervening strip of firm ground, they have formed a small archipelago of clay and silt islands. The arm C was the only one that resembled an actual river, and it was in it that we measured the greatest depth; its banks too were the only ones that were overgrown with kamisch.

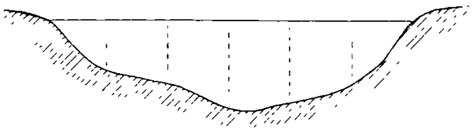


Fig. 123.

| Right. | 1.42 | 1.74 | 2.49 | 2.32 | 1.56 | = depth. Left. |
|---|---|---|---|---|---|---|
| | 38 | 67 | 31 | 68 | 41 | velocity. |
| | 42 | 79 | 88 | 71 | 23 | |
| | 54 | 81 | 89 | 74 | 10 | |

Breadth = 9.8 m. Branch C, March 31. Scale 1 : 200.

To determine with perfect accuracy the volume in a watery labyrinth such as this is of course impossible. The total I have arrived at above is certainly a good deal too small. For one thing, it blew hard from the north-east all day, and as the wind was dead in the teeth of the flow, the velocity must obviously have been retarded. And a gauge-staff which we put down near our camp pointed to the same conclusion; for whilst the wind lasted there was a very appreciable rise in our creek, but no sooner did the wind drop in the evening than the water subsided to its normal level.

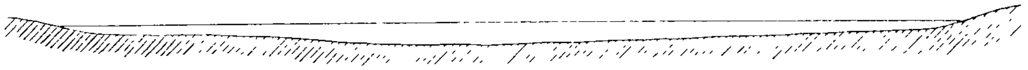


Fig. 124.

| Right. | 0.58 | 0.87 | 1.10 | 1.05 | 0.94 | 0.67 | = depth. Left. |
|---|---|---|---|---|---|---|---|
| | 3 | 10 | 40 | 42 | 21 | 12 | velocity. |
| | 11 | 13 | 37 | 34 | 17 | 20 | |
| | | 2 | 19 | 31 | 2 | | |

Breadth = 50.1 m. Branch E, March 31. Scale 1 : 400.

Moreover, it may be regarded as pretty certain that one or other arm escaped my observation through being hidden in the reeds. But the most important factor is that there were two arms which we probably did not see at all, for my pioneers assured me that they crossed eight arms by *swimming*, without counting those they waded over on foot. But we found only five arms, with another near Camp No. CLXVII, which carried 4 cub.m. in the second, and could be crossed by wading. But even counting that, there were still two arm awanting between F and Camp No CLXVII. But we were unable to advance beyond F either with the canoe or on foot; nor could I glean any intelligible account of the country to the east.

Including the two arms which stopped our march in the vicinity of Camp No. CLXVII, and carried volumes of 4.0 and 2.35 cub.m. respectively, we had obtained a total volume of 33.59 cub.m. as the quantity of water speeding north to feed the new desert lakes. Every probability points to the actual volume being between 40 and 50 cub.m.; but, that I may not be guilty of any exaggeration, I will in the following discussion take 35 cub.m. as being the inflow per second into the new lake.

From this inquiry it results, to begin with, that in the end of March 1901 the Kara-koschun was no longer the terminal basin of the Tarim; but, the bed of that marsh being choked with sedimentary matter, it was soon brimming full, and the excess, running over where the margin was lowest, was continuing to flow to the north. Nor would this overflow cease until after the influx from the Tarim decreased to such an extent as to cause a considerable drop in the Kara-koschun. But on the assumption that the subsidence in all the lakes was equal, the Kara-koschun would go on discharging water into the new lakes until its surface dropped 2.49 m., the deepest point in the shallowest vertical section of the arm C. This is of course on the further assumption, that there exist in these northern lakes depths which exceed 2.49 m.; otherwise the overflow from the Kara-koschun would cease sooner.

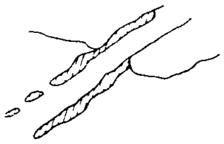


Fig. 125. PIERS OF KAMISCH AT THE MOUTH OF ARM C.

I have said that the Kara-koschun is no longer the terminal reservoir of the Tarim system; that position has been taken by the newly formed lakes in the desert to the north. The Tarim does indeed still continue to empty itself into the Kara-koschun; but a great part of the water flows out of it again. The arm C has, as I have shown, all the attributes of a real river, and clearly forms a direct continuation of the Tarim, being its last and remotest tentacle; nor will it be long before the other arms also become transformed into distinct river-beds. The banks of the arm C, which consist of clay, silt, jardangs, and mounds bearing tamarisks, are almost entirely clothed with kamisch. These rather narrow ribbons of kamisch project a little on each side into the lakes after the manner of piers, the kamisch growing on shallow mud-banks formed by the current. In this we have an exact repetition of the course of the Tarim through the Kara-buran. For the sake of comparison I add my description of the river in that lake in the year 1896.*

Wo Tarim den Semillaku-köl verlässt, ist die Tiefe 1.85 m.; das Wasser ist nicht ganz klar, und wir finden sogleich, dass wenigstens ein grosser Teil desselben die Klärungs-Seen nicht passiert hat. Rechts erreichen wir bald darauf die breite, deutliche Mündung des Tschertschen-darja, jetzt nur wenig Wasser führend, und dann breitet sich auch an der rechten Seite der letzte Rest des vor 20 Jahren so grossen Kara-buran aus. Heutzutage its der Fluss vom See ganz und gar geschieden. Das tief eingeschnittene Flussbett ist scharf gezeichnet, links liegen einige kleine »dschajis« oder Lagunen, rechts ist das Flussbett vom See durch einen natürlichen Damm geschieden. Letzerer ist sehr schmal, anfangs nur einige Meter breit, dann allmählich breiter, und ist überall mit Kamisch bewachsen. Er scheidet scharf das tiefe Flussbett von dem sehr seichten See. An einige Stellen ist der Damm unterbrochen, an andere bis hundert oder mehr Meter breit und besteht aus feuchtem Schlamm.

Wenn das Wasser im Sommer verdunstet, hat der Fluss dasselbe Aussehen wie sonst in der Gegend, und man hat keine Ahnung von der Existenz eines Ufer-Sees. Der lange, eigentümliche und scharf ausgeprägte Pier, den man fast auf künstlichem Wege gebaut glauben sollte, entsteht wohl teilweise dadurch, dass eben an der Uferlinie die Vegetation reichlicher ist, und deshalb sich Staub und Sand ansammelt, so dass ein schmaler Streifen Boden am rechten Ufer höher zu liegen kommt, als die weiter südlich gelegene Gegend, welche deshalb vom Hochwasser überschwemmt wird, doch so, dass die Schwelle sich immer ein wenig über die Wasseroberfläche erhebt.

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* *Peterm. Mitt.*, Ergänzhft. 131 pp. 104—105, whence also the accompanying illustrations are taken.

Der Kara-buran war jetzt nur einige kilometer breit und von W. nach O. ausgezogen. Im Mai wird der See vom Fluss ganz und gar isoliert, wobei das Wasser salzig wird, dann trocknet es aus.»

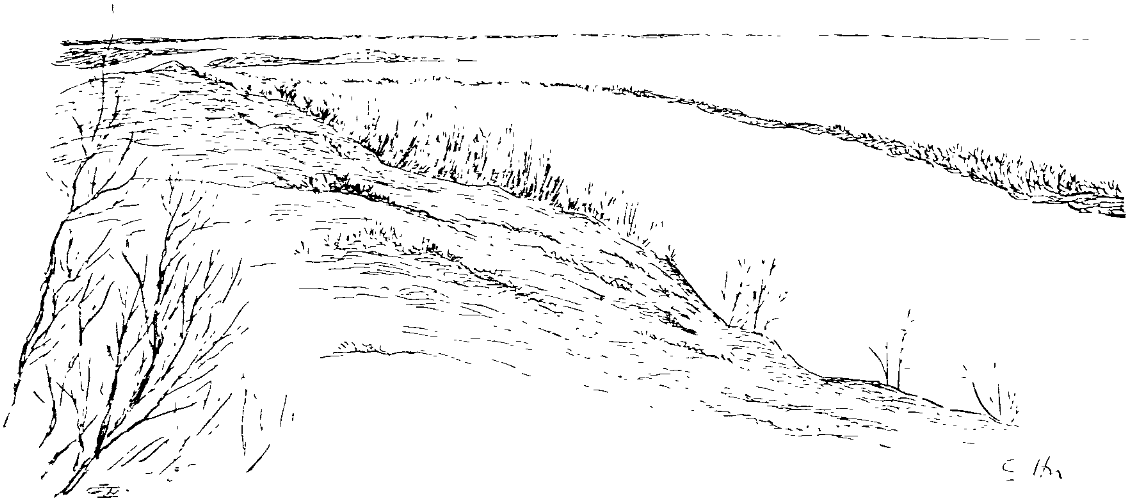

Fig. 126. VIEW TOWARDS S 70° E ACROSS THE KARA-BURAN, AS IT WAS ON 19 APRIL 1896; BETWEEN THE BANK TO THE LEFT AND THE NARROW KAMISCH-PIER TO THE RIGHT IS THE RIVER TARIM; BEYOND THE PIER IS THE LAKE.

If now we compare the exit of the arm C out of the Tschajnot-köl with this description, and compare the illustrations from the two places, there cannot be the slightest doubt that the same processes of formation are going on in both cases alike, the only difference being that the development has proceeded farther in the Kara-buran. In Prschevalskij's time (1876—77) this lake was still pretty big: — »Lake Kara-buran itself is from thirty to thirty-five versts long, and ten to twelve versts wide. Its area, however, depends a good deal upon the quantity of water in the Tarim; at high water the flat shores of the lake are flooded for some distance, whilst at low water the salt marshes on its borders are uncovered. Lake Kara-buran is not above three or four feet deep, and in places even less than this, although occasional deep pools occur, and the open space free from reeds is comparatively larger than in Lop-nor».*

According to Pjevtsoff the lake had in 1890 a circumference of 60 versts. If these statements be compared with my observations (see above), it will be found that the Kara-buran is a vanishing lake, having during the course of the last twenty-five years shrunk to a transitory sheet of insignificant extent, which dries up entirely in the summer. The shrinkage of this lake has advanced much faster than the shrinkage of the Kara-koschun, for the Kara-buran has received and retained amongst its kamisch all the sediment that the Tarim has brought with it. Upon issuing from the lake, the river was pretty clear, and the sediment which settled in the Kara-koschun is for the most part such as it picks up whilst traversing the distance between the two lakes. Within a short time the Kara-buran will have disappeared entirely. The river has already thrown up piers, as we have seen, and these mask its present course and its banks; all that now remains to be filled up are insignificant parts of the Kara-buran, and the lakes lying to the west of it as far as the district of Tschigelik-uj. As soon as this has been accomplished, the river will go direct to the Kara-koschun, carrying with it the whole of its sediment, and then that marsh will silt up at a more rapid rate than it has done during the time the Kara-buran has served as its clearing-basin.

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* *From Kulja etc.*, D. Morgan's ed. p. 97.

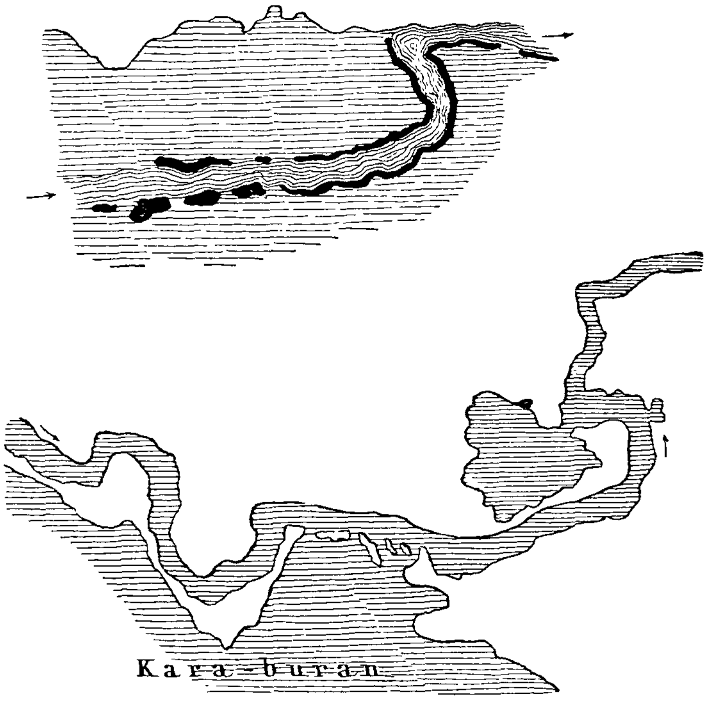

Fig. 127. FORMATION OF PIER-LIKE RAMPARTS WHERE THE TARIM GOES THROUGH THE KARA-BURAN.

The next stage in the development will be that the Kara-koschun will serve as the clearing-basin, that is to say it will perform the same function that the Kara-buran has done. We have already seen that the branches of the river-mouth became distinctly shallower between 1900 and 1901, to the profit of the side-canals situated higher up its course. It is through some of these that the main body of the river will eventually flow, and it will continue onwards as a deep trench through the shallow marshes, which will hang upon it like marginal lakes, especially on the south, just as the Kara-buran does now. Meanwhile the river will build up mud-banks along its sides, and these will part it from the marshes. The first step in the direction of this development is discernible in the arm C, which already has long piers, especially at its southern extremity. One may say with perfect justice, that its water is the very last in the whole of the Tarim system that flows through a fluviatile bed. Its muddiness might well mislead one into believing that it flows direct from one of the deltaic arms of the Tarim at Kum-tschapghan; though this is scarcely likely, because of the great distance and the great number of the intervening marshes. The muddiness of the water was a secondary phenomenon, depending partly upon the nature of the clay banks, partly upon the violent wind which was blowing on the 31st March. Moreover the water in the extreme western part of the Kara-koschun was perfectly clear. In the other arms too the water was clearer; whence we may also infer that the appreciably greater velocity of the arm C also contributed to the muddiness of the water. Finally, all the arms are newly formed, as is patent from the distribution of the vegetation — another circumstance contributory to the turbidity of the water.

Here too we have precisely the same bathymetrical relations as in the Kara-koschun, the arm C being deeper (4.40 m.) than the adjacent lake-basins. One rather striking circumstance is that at the point where the arm C empties into the new lakes, its velocity is a good deal greater (0.5572 m. per second) than the velocity of the Tarim when it discharges (0.3363 m.) into the Kara-koschun at Kum-tschapghan. At the same time it is to be borne in mind, that the whole of the difference of level between the Kara-koschun and the new lakes is by no means concentrated into the short arm C, but the slope, although everywhere extremely gentle, is nevertheless continued to the north beyond that point, and in fact there is a distinct current perceptible in the sheets of water that have penetrated farthest north. After reading Kosloff's statement, that the Kara-koschun continues on to the foot of the eastern Kuruk-tagh in the form of marshes and *solontschaki*, one might expect to find that it had overflowed its bounds and sought a path for itself towards the east-north-east. But as a matter of fact, the overflow proceeds towards the north, the ground being lowest in that quarter, actually lower in fact than the level of the Kara-koschun.

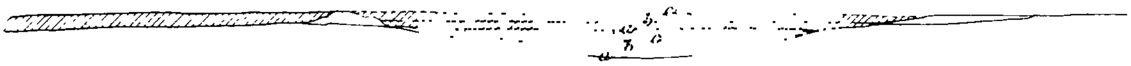

Fig. 128.

On the whole it is a rather narrow strip of land through which all these streams cut their way between Camps CLXVII and CLXXIV, namely the strip that has hitherto formed the northern shore of the Kara-koschun of Prschevalskij. The portion of it lying between the arms C and E is a veritable rampart of clay ridges, sand, and gigantic tamarisk-mounds, most of them with living bushes, as well as some kamisch. We discovered another similar rampart farther east, though less distinctly developed. The outline of the lake-shore has of course prescribed the direction of the belt of vegetation, and this in its turn has bound the solid material together, and so given rise to the rampart. For a certain time this rampart kept the lake within appropriate bounds. In the accompanying illustration *a* is the original bottom of the lake, and $a_1$ its surface. After the basin has been partly filled with silt, sand, and decaying vegetation, the bottom lies at *b* and the surface at $b_1$, abutting upon the root-bound rampart on the north. On the south however there is no such rampart, but the rise in the surface is much more considerable. In a third stadium the lake-basin is, as it were, lifted up to the position *c*—$c_1$, and its surface then lies higher than the desert to the north. There is of course a limit to the elevation of the lake-bottom, just as there is to the elevation of the bottom of the Tarim, which however brings about the overflows of the river, and produces its marginal lakes and the changes in its bed. In the Kara-koschun also the shore rampart is at length breached, and the masses of water pour themselves through to the north. This explains why the islands between the several arms A to F are so long and so narrow. The rampart is strongest just where the breach has occurred, and where beyond it the surface to the north is relatively lowest. Further east, as my survey demonstrated, there was no need for a rampart, the ground itself rising there into a ridge or threshold two or three meters high. A long time has of course been necessary to effect this elevation of the whole of the Kara-koschun basin, and during that time there have been periodical risings and fallings of the water-level, the result partly of the high and low water at the different seasons and partly of the varying precipitation in different years. Moreover, as we have seen, the lake has on the whole shrunk seriously in volume since Prschevalskij's time. One would suppose, then, that the natural rampart I have been speaking of would be less and less exposed to the danger of being cut through as the years went past. But the effect that is produced by the general shrinkage is not only counterbalanced, it is outweighed, by the effects produced by two other factors, namely the filling up of the basin and the excavation of the desert to the north in consequence of the wind's energy — a problem to which we shall return in another connection. Hence at some time in the past, e. g. 100 or 150 years ago, the Kara-koschun may have extended to double its present area, nay to an area several times the double of the existing area, without any overflow taking place to the north. It is to that epoch that we must ascribe the origination of the belt of *schor* which occurs in several places along the shores. It is of course impossible to follow in detail all the oscillations that have taken place, nor is it always easy to unravel the causes which brought them about. The object of these investigations of mine is to trace out the great laws of the forces which have been operative there, and to discover the principle underlying the migrations of the lake of Lop-nor.

# CHAPTER XV.

## GENERAL CONCLUSIONS REGARDING THE KARA-KOSCHUN.

Owing to our defective knowledge of the Kara-koschun, it is practically impossible to state its area and cubical capacity. At the present time there exist only two navigable waterways through the reeds in its westernmost parts. The whole of its eastern portion, amounting to probably three-fourths of its entire length, is absolutely inaccessible, — except by balloon. Add to this, that its eastern end has not been mapped. Still, taking the data so far as they exist, it is possible to make an approximate estimate. If with Prschevalskij and Pjevtsoff, we take the length of the marsh as being approximately 100 km., and the mean breadth as drawn from my own observations at 25 km, we obtain the area of 2,500,000,000 sq. m. According to my soundings of 1900, the mean depth is 2.366 m.; taking the northern waterway, the mean depth is 2.70 m., taking the southern 1.0 m.: the mean of these two means is 1.85 m. On the basis of this value for the mean depth, the volume works out at 4,625,000,000 cub.m. However it may safely be assumed, that the mean depth of the Kara-koschun is not so much as 1.85 m.; for it has to be remembered, that all the soundings were taken not only in the two open channels, which are of course the deepest, but in *their* deepest parts. Moreover the entire lake is overgrown with kamisch, which as a rule grows only in very shallow water, and at the same time collects and holds together the silt, dust, and drift-sand. Towards the east-north-east, the direction in which the surface rises, the depth grows *a priori* less and less; and it is precisely in that part of the lake, as I have mentioned above, that by far the greatest part of the drift-sand accumulates. In short, I do not think that at the present moment the lake's mean depth reaches one meter. Putting the mean depth however at one meter, then the cubical capacity of the marsh is 2,500,000,000 cub.m. — in the beginning of April. But as the volume of the river in the beginning of April is considerably greater than the mean volume for the entire year, the result at which we have arrived above is too large rather than too small to be accepted as the general mean for the lake. If the evaporation in this part of Asia is as great as in the Lake of Aral, which, according to the statements of Russian inquirers, loses a layer of about one meter in thickness every year,* simply through evaporation, then the Kara-koschun would dry up entirely in the course of the year—were the lake not constantly fed by the Tarim. As an actual fact, the evaporation here will be even greater than in the Lake of Aral, for not only has the Kara-koschun an incomparably smaller area, and is surrounded on all sides by desert, but its evaporation is enhanced by its vegetation, its considerably greater elevation, the freshness of its water, and the constant wind that blows. Since then the river drops to its lowest level in the summer, and its evaporation in June is certainly not less active than at Nukus, the marsh should not be especially far from actually drying up every year, or at all events it should dwindle to a comparatively insignificant residue, as indeed the natives aver that it does. If the Kara-koschun goes on shrinking at the same rate as it has shrunk during the last 25 years, it will sooner or later become nothing better than an ephemeral pool, drying up completely in the summer, filling again in the autumn, remaining frozen all winter, perhaps even becoming dry again sometimes in the spring, and once more filling with water after the ice melts. Yet before anything of this kind comes to pass, it is probable that the above-mentioned changes will have already taken place; that is to say, the remnant of the marsh will have become converted into a marginal lake of the character and rank of the Kara-buran, and the Tarim will empty itself into the recently formed lakes to the north, which again, in the fulness of time, are in their turn destined to disappear.

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* Mohn tells us that at Nukus in the month of June alone the evaporation amounts to 500 mm. See his *Meteorologi* (Christiania 1903), p. 152.

The life of the existing Kara-koschun is therefore ebbing fast; it is like a flickering flame which leaps up for a moment when fresh oil is poured into the lamp, but after that droops again, and threatens to go out.

I have already given an account of the measurements of the river which I made on four different occasions at Jurt-tschapghan. All we know about the volume at this point is, that the Tarim on 21st April 1896 had a volume of 61 cub.m., on 13th April 1900 of 86 cub.m., on 25th June 1900 of 39 cub.m., and on 3rd April 1901 of 141 cub.m. Arranged according to the seasons, and subject to the condition that the general volume of water was the same in each of the three years quoted, these *data* furnish a regularly descending curve, steep in the beginning of April, but growing flatter as the year goes on. Were I, using these data, inadequate though they be, and relying also upon my own observations in other districts higher up the Tarim, as well as upon the verbal information of the natives — were I to attempt to draw up a provisional sort of table, it would assume something like the form which follows:

| | Cub m. per second. | | Cub m. per second. |
|---|---|---|---|
| 3rd April | *141* | Beginning of July | 35 |
| 13th | *86* | Middle » » | 30 |
| 21st » | *61* | End » | 25 |
| Beginning of May | 57 | Beginning August | 20 |
| Middle » | 53 | Middle » | 20 |
| End » | 49 | End » | 30 |
| Beginning June | 45 | Beginning September | 55 |
| Middle | 42 | Middle | 80 |
| 25th June | *39* | End » | 110 |

| | Cub.m per second. | | Cub.m per second. |
|---|---|---|---|
| Beginning of October | 150 | Beginning of January | 35 |
| Middle » | 170 | Middle | 30 |
| End » | 160 | End | 25 |
| Beginning November | 120 | Beginning February | 25 |
| Middle | 80 | Middle » | 30 |
| End | 60 | End » | 35 |
| Beginning December | 50 | Beginning March | 45 |
| Middle | 45 | Middle » | 100 |
| End » | 40 | End | 160 |

During my short stay at Abdal in 1896 the information which was given me with regard to the annual changes of level was imperfect: »Von Juni bis August ist der Fluss hier am niedrigsten. Im September steigt das Wasser zu derselben Höhe wie im April, aber erst im Oktober kommt das Hochwasser, also mit dem Raskan-darja verglichen 4 bis 5 Monate verspätet. Dann sinkt es, doch nur sehr wenig, bis April; aber vom April bis August sinkt das Wasser täglich ungefähr zwei Finger breit.»* What is especially incorrect here is the statement, that the fall between October and April is insignificant. That a very serious drop does take place between October and December is clear from the fact that at Karaul on 5th December I measured a volume of only 55 cub.m., and this by the time it reaches Jurt-tschapghan is very much further reduced. In January the volume can hardly be much greater than in August, because of the great quantity of water that freezes up. The level does not begin to rise again until the end of February; but in the beginning of March the volume is somewhat less than in the beginning of December, and the maximum of the melted ice-water, or the spring-flood, which passes Jangi-köl about the 13th March, does not reach Jurt-tschapghan until the end of March; then follows the rapid drop indicated by the first three figures in the above table.

How far, as I have there assumed, the autumn flood is bigger than the spring-flood, or whether the reverse is the case, or whether both are equally large, or whether sometimes the one, sometimes the other is the larger, it is impossible to determine with the scanty materials I have at my disposal. In any case Pjevtsoff's statement,** that the lowermost Tarim stands highest in May (O. T.), is incorrect. This deduction is based upon one spring-flood only; and I myself fell into a similar error in 1896, when I relied upon a single autumn-flood, and took no account of the imposing spring-flood that results from the melting of the ice.

And although the table which I have given is in great part hypothetical, it nevertheless does afford some idea of the fluctuations of volume; and after making the alterations in the figures that would be necessary as a consequence of continued observations on the spot, the curve for the year would actually present the appearance shown in fig. 129, subject to slight modifications.

My reason for introducing these calculations in this connection is to obtain support for my hypothesis, that the Kara-koschun did not on 1st April 1901 contain more than 2,500 million cub.m. of water. If, as we also assumed, precisely this same amount evaporates every year, then it is necessary that the river should all the year through contribute to the lake a volume of 79 cub.m. per second; for if that is the quantity of water that evaporates every second, it is obvious that the same quantity must enter the lake every second if the balance is to be preserved. And if the 79 cub.m. of evaporation be regarded as a pretty constant value — and this we may indeed assume, considering the continental position of the lake and the small range of the climatic changes — it is evident that, whenever the inflow exceeds 79 cub.m. in the second, the lake must expand, and when it falls below that amount, it must shrink. The mean of the four measurements I made at Jurttschapghan is 82 cub.m. in the second; but this figure is too high, because three of the constituent data were obtained in periods when the general volume was exceptionally large and only the fourth belongs to a period of low water. If now we take the middle figure of the first three, namely 86 cub.m., and conjoin with it the fourth, or 39 cub.m., we get a mean of 62 cub.m. Again, if we take the mean of the table as a whole, we obtain 64 cub.m. as the mean volume per second throughout the whole of the year. On this basis the lake would not receive during the course of the year more than 2,018 million cub.m. From this it results that in all probability the mean depth of the Kara-koschun is not so much as 1 m.; that my

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* *Peterm. Mitteil.*, Erghft. 131, p. 109.

** *Trudij* etc., p. 307.

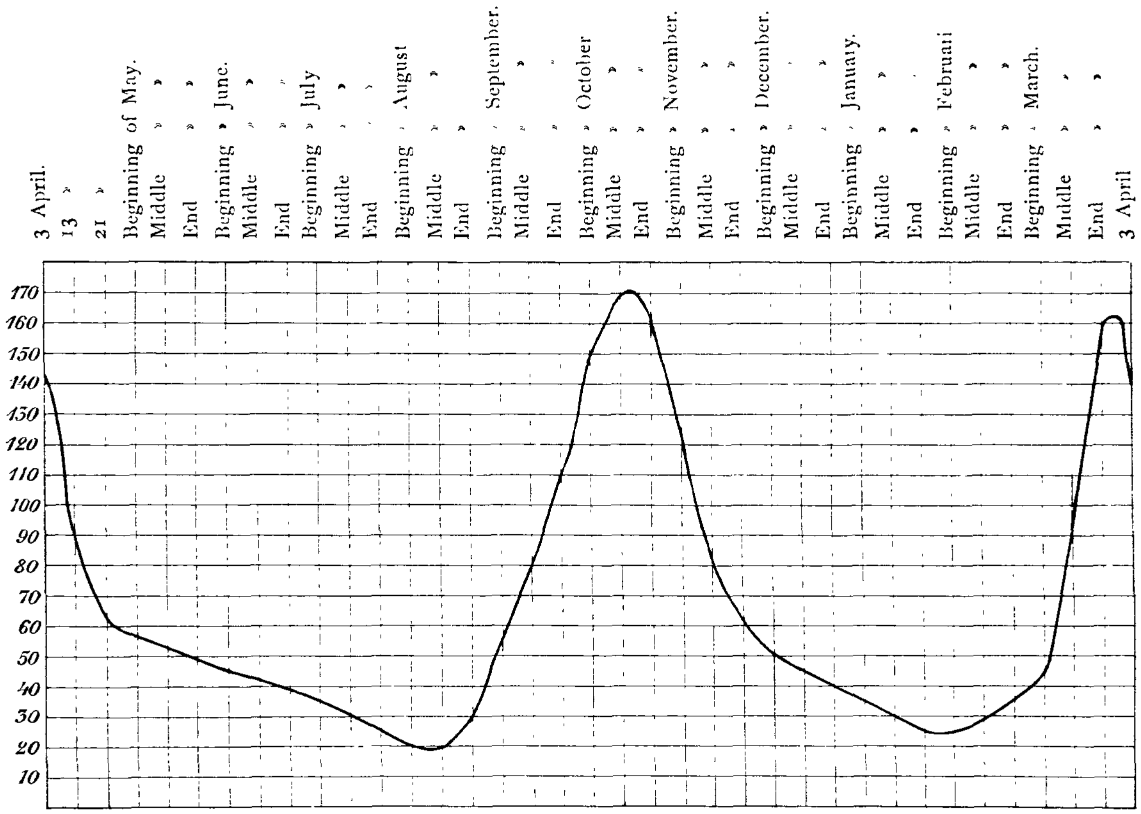


Fig. 129. THE VOLUME OF WATER IN THE TARIM DURING THE COURSE OF THE YEAR. THE COLUMN TO THE LEFT GIVES CUBIC METERS IN A SECOND.

hypothesis, that the lake has a capacity of only 2,500 million cub.m., is at all events not too low; and that Kosloff's statements as to the enormous extension of the lake to the north-east may be entirely left out of account. On the basis that the length and breadth really are what I have assumed them to be, namely 100 and 25 km. respectively, and if the volume is 2,018 million cub.m., then the actual mean depth will be only 0.81 m., and this I regard as being very near the actual truth. If, again, the annual evaporation amounts to one meter or more, it follows as a direct consequence, that in the summer, when the evaporation is incomparably much more active than at other seasons of the year, exceptionally large areas of the lake must dry up completely, and water will remain only in the deepest basins, especially in that part of the lake which is traversed by the northern waterway, in which, as we have found, the mean depth was 2.7 m. At the present time this is the only part of the lake in which fishing is carried on, apart from the westernmost division of the southern waterway, where there is water all the year round. Hence it is easy to understand why the natives pay no heed to the desiccation of the other sections of the lake. The information I gleaned, already set forth above, agrees in every respect with the assumptions I have just made.

The great changes which are taking place in the country of Lop must be considered in common from several different points of view. For, if we merely take into account the hydrographical relations, and reflect that even Prschevalskij pronounced the Kara-koschun to be a dwindling lake, and remember that since his time it has gone on shrinking still further and to a very considerable degree, it does seem absurd, that now, when it is less than it ever has been before, it should overflow the bounds within which it has hitherto been confined. But if we take as the focus of the entire series of operations the solid material, which, transported by wind and water, has accumulated in its basin, then the overflow is no longer a matter for special remark, but is in the highest degree both natural and inevitable.

In Chapter XIX of vol. I I have made certain calculations with regard to the 35 marginal lakes on the right bank of the Tarim, and found that their area amounted to about 564 million square meters, or about one-quarter of the area of the Kara-koschun. Their combined capacity amounted to 2667 million cub.m., or rather more than that of the terminal lake, the reason being that their mean depth is as much as 4.73 m., or more than double the mean depth of the open parts of the Kara-koschun, and nearly six times as much as its assumed mean depth. These small marginal lakes have a very innocent appearance on the map, where their combined area is only equal to one-fourth the area of the terminal lake; but their volume is greater than that of the Kara-koschun, and that in the beginning of April, just after this basin has been filled by the high flood. The volume of these desert lakes does not however mean that that amount of water is abstracted annually from the Tarim, for several of them have their connection with the river severed for years together. The tribute they levy upon the Tarim, and hence the detriment they do to the Kara-koschun, is caused for the most part by their evaporation: and that we have assumed to be equivalent to a layer of water one meter deep every year, or in other words a total amount of 564 cub.m. annually, or an average of 18 cub.m. in the second. The disappearance of these marginal lakes would mean an increase in the volume of the Tarim to that amount, and would bring up its volume from 64 to 82 cub.m. as the mean per second, notwithstanding the losses which inevitably take place on the way down to the mouth of the river. The total volume which under those circumstances would be poured into the Kara-koschun would amount to 2585 million cub.m., or one-fifth more than the total cubical capacity of 2,018 million cub.m., which we have calculated it at above. The origination of these 35 marginal lakes is therefore a factor of great importance for the Kara-koschun, and we ought also to remember, that in addition to them there are innumerable others all along the course of the Tarim. The river would only need to change its bed in the vicinity of Jangi-köl and the supply to the lakes would be cut off, and the Kara-koschun would at the same time be appreciably enlarged. Their existence is certainly one of the causes of the shrinkage which has taken place in the terminal lake during the latest phase of its history. Whether in the time antecedent to that they stood in any sort of mutual relation to the Kara-koschun, as also whether they are at the present time expanding, cannot be decided, though it is probable that both questions should be answered in the affirmative. Perhaps the raising of the lake-basin as shown in fig. 128 does have some sort of relation to the origination of these marginal lakes; for if the water-level of the Kara-koschun were raised, it would naturally of necessity react upon the lowermost Tarim, as a sort of ascending wave, or general elevation of the level of the river, resulting in an arrest of erosion and an increase in sedimentation. But now, that the river appears to be deserting the Kara-koschun, and new lakes appear to be forming to the north of it, the difference of level between them and the lower Tarim is greater, and perhaps this circumstance so far will prove detrimental to the marginal lakes and advantageous to the new lakes to the north of the Kara-koschun. Meanwhile however the difference of level is so slight that any effects it may have are as yet minimal.

Bogdanovitsch received the same impression that I did in 1896, namely that the terminal lakes of the Tarim are, as it were, travelling *up* its stream. This inference is suggested by the great number of recently formed deltaic arms which break off from the river above Kum-tschapghan, and which grow every year at the expense of the arms that exist below them, as well as at the cost of the Abdal lakes and the new lake-basin which has formed between the lowermost Tarim and the Tokus-tarim. But the inference is erroneous; the movement which it presupposes is only apparent and accidental, and is contradicted by the formation of the new lake-basin to the north of the Kara-koschun. The real fact is, that the Kara-koschun is so nearly completely filled up that the water *must* gather elsewhere, either to the west or to the north of it.

It is difficult to determine with complete certainty what the relations are which obtain between the northern lakes and the Kara-koschun. All we know is, that the former were receiving on 31st March a volume of 34 cub.m. in the second, or rather less than the volume which the Tarim carried altogether at Jurt-tschapghan on 25th June. Further, we know that this river had at the same place on 3rd April a volume of 141 cub.m., and it was then subsiding; in other words, the 34 cub.m. was coincident with the high flood of spring, which we have taken to be 160 cub.m. Now the question arises — does the inflow into the northern lakes decrease proportionally to the decrease in the. volume at Jurt-tschapghan, or is it virtually independent of that decrease, in the same way as the Tarim is at Kum-tschapghan? I have shown, that when the volume diminishes at Jurt, the canals dwindle away one after the other, but at Kum the volume remains within certain limits virtually constant. If the same conditions prevail in the arm *c*, which communicates with the new lakes, it would mean that the main body of the water, or the true stream of the Tarim, proceeds thither undiminished; and that this probably is the case is suggested both by its greater velocity and by the incipient attempts at rampart-formation which we noticed at each end of the arm, in the two adjacent lakes that it links together. The formation of these northern lakes must occasion a considerable lowering of level throughout the Kara-koschun, and consequently large areas of its domain must have been converted into dry land, a circumstance which would naturally in a high degree facilitate the rampart-building operations of the continuator of the river, the arm C. But seeing now that the greatest depression in that region no longer exists within the confines of the Kara-koschun, but outside them to the north, it is clear that the stream is aiming to avoid the old lake, at all events the dry exposed portions of it, and is striving instead to flow directly to its real terminal lake.

If on the other hand we assume that the volume in the arm C. is all the year round proportional to the volume at Jurt-tschapghan, that is to say, if it forms the same curve as is shown in fig. 129, the corresponding stadia being each a little later in date, then the arm C will carry a mean volume of 13.6 cub.m. in the second, or 429 million cub.m. in the year. What direction its development will take can only be decided by fresh investigation. One thing however is certain, that the new lakes will be as ephemeral as the Kara-koschun, and while expanding after the high flood, they will dry up almost entirely in the summer. There can be no doubt that the recently formed Tokus-tarim arm is intimately related to the new lakes, in that both have come into existence since the old basins became filled up with sediment, and consequently became no longer serviceable.

When describing our return from this interesting journey I shall have another opportunity to touch upon the last-named river-arm. We started on 1st April, our goal being Jurt-tschapghan. Great changes had already taken place on the northern shore of this the western part of the Kara-koschun; a large part of the route we followed the year before was now under water, and we had to adopt a more northerly line of march. Nor had we advanced very far towards the south-west before we saw wide expanses of water spreading to the north of us, so that we were travelling along a promontory of varying breadth, and traversed by ranges of dunes. Hence from these lakes, which are formed from the Tokus-tarim (issuing at Schirge-tschapghan), it is no great distance to the new desert-lakes, and no doubt they are endeavouring to effect a junction with them, and will effect a junction with them unless they are prevented by a threshold not evident to the eye. At intervals we observed the usual dead vegetation — tamarisks, kamisch, and two or three poplars, one decimeter thick. On the south we had the parts of the Kara-koschun known as Jaghisma-köl and Tschöl-köl.

The water from the Tokus-tarim was now divided into three arms. The first, which was 9.81 m. broad, had a mean depth of 0.440 m., a mean velocity of 0.3165 m., and a volume of 1.37 cub.m. in the second. Shortly after that we waded across a narrow, shallow offshoot of the lake, and were then surrounded on all sides by wide expanses of water, the mutual connections of which it was difficult to make out. In several places the dunes plunged steeply down into the lakes, and occasionally the tamarisk-mounds projected above the surface like little islands. The second branch had these dimensions—breadth, 10.35 m.; mean depth, 0.483 m.; mean velocity, 0,7014 m.; and volume, 3.51 cub.m. in the second. The breadth of the third branch, which was in the same vicinity, was 11.9 m.;the mean depth, 0.593 m.; the mean velocity, 0.4424 m.; and the volume, 3.12 cub.m. in the second. We pitched Camp No. CLXXV on a narrow tongue of land beside the lake from which the arm issued. The kamisch was pretty thick on its northern shore, and beyond the kamisch were some rather low dunes. The arm in question resembled here a well-developed river-bed, having sharp-cut terraced banks on both sides. Thus the Tokus-tarim issued at Schirge-tschapghan from the »dividing» lake, the Jäkänlik-köl, with a volume of 8 cub.m. on 1st April, as compared with a volume of 3.5 cub.m. on the 5th April of the year before. Possibly this difference of date may have had some effect upon the volume, though it is difficult to believe it, owing to the great number of lake-basins which we passed, and which regulate the volume and retard the fall. It may therefore be assumed, that the difference is indicative of an increase between 1900 and 1901. On 16th April 1900 the Tokus-tarim had higher up its course a volume of 9.41 cub.m. Had the proportion between the volume at that place and at the crossing-place of 1901 remained the same, the Tokus-tarim would then have a volume of 21.5 cub.m., and thus be a considerable stream, quite as big as the Jarkent-darja in September. Seeing that all this water issued from the Kara-köl lakes, it would appear that the eastern lake and river system had experienced a noteworthy increase during the course of the year. Herein we have a fresh proof of the view, that the system of the lower Tarim is as a whole shifting, partly from south to north and partly from west to east; and this moreover is in agreement with the fact that the terminal lake of the system is moving northwards to the old basin of the Lop-nor. The directions assumed by the three branches in question are indicative of the extreme flatness of the country. The first flows towards the north-east, the other two to the south-west. They now discharge their 8 cub.m. into the Kara-koschun, so that this must be added to the mean annual volume of 64 cub.m. which enters it from Jurt-tschapghan. Agreeably with my own observations and the statements of the natives, the Tokus-tarim is growing annually at the expense of the Tschong-tarim. Besides the increase in volume and the addition of a third arm, there is yet another circumstance calculated to confirm this supposition, namely the fact that the northern lakes have also increased enormously since 1900, when they were still but small sheets of water. But while in 1900 they were still perfectly bare and barren of vegetation, in 1901 they were encircled with kamisch; which is here disseminated with incredible rapidity by the currents, not by the wind, for the wind blows in the opposite direction. Thus from Camp. No. CLXXV it would have been possible to paddle with ease to almost any point we chose in the watery labyrinth of the Lop country, nay even half-way across the Desert of Lop in the direction of the ruins of Lôu-lan. I have already drawn attention to the fact that all these lakes of the Tokus-tarim will soon be filled with sediment, and the river will then flow on without interruption. Hence it is probable that in the future the Tokus-tarim will become a left-hand tributary of the Big Tarim, the two streams uniting very close to the point where the last-named empties into the northern lakes. But before that event comes to pass, it may also happen that the Tarim will shift over into the bed of the Tokus-tarim; in that case the Tschertschen-darja would be the only tributary joining the main stream from the right.

In the course of our day's march on 2nd April, we observed that various changes had taken place in the distribution of land and water; but we were quite unprepared to find that the sections of the lake which lay in that quarter had shrunk and retired from the route we followed the year before. Probably the cause of this is the general lowering of the Kara-koschun by the new lakes, which set up a process of »suction» from west to east. This would explain how an advance of the shore-line southwards in the western part of the Kara-koschun can synchronise with an advance of the shore-line northwards in its eastern part. But probably other causes cooperate to produce this apparent anomaly. Of the flowing Tarim water a large portion travels along the northern shore of the lake, but a still greater portion keeps close to its southern shore; and between these two currents there does not appear at the *present time* to be any moving water. Accordingly the active currents that do exist transport the greater part of the fluviatile sediment to the shores of the westernmost division of the lake. The drift-sand also contributes to fill up the lake under its northern shore, although to a smaller degree owing to the south-west to north-east trend of the shore-line. A distinct change was also noticeable in the grouping of the dune-sand; for the dunes were then considerably smaller than they were the year before. Most of them indeed were rudimentary, and leaned upon tamarisk-mounds, frequently of unusual height, which, now that the sand was being blown farther west, were coming out into stronger relief and standing more and more free. The reason of the sand having decreased in quantity was that this part of the desert was now surrounded on all sides by water. But the sand on the big island no longer receives any increment from the north-east and east-north-east; but notwithstanding that it still continues its onward movement, so that by far the greater part of it settles in the lower Tarim, where it still further contributes to elevate the bed of the river.

The different parts of the Kara-koschun which we passed on our way from Camp No. CLXXV bear the following names—Kirtschinlik-köl, Sägislik-köl, Äschäk-kormatsch-köl, Jegrenlik-kir, Ajsu Niasne-köli, Kakmak-tschantschdi, Alim Chodschane-köli, and Ajs Ullugh-tschapghan. Leaving some distance to the south Kum-tschapghan and its tamarisk-mound, visible a long way off, we directed our march to the eastern shore of the lake of Ak-köl, which lies north of the very lowest stretch of the Tarim, and was formed six years ago, but in 1901 had swollen to such an extent that it was expected it would reach as far north as the district of Jangi-jer. This lake, Ak-köl, which is in great part overgrown with reeds, we crossed by canoe. Then followed the lakes of Kongurtschaktik-köl and Jangi-köl, while the vast open expanses of the Turkomaktik-köl stretched away to the right. Finally we passed from the Örtäng-köl through a breach in the narrow dividing

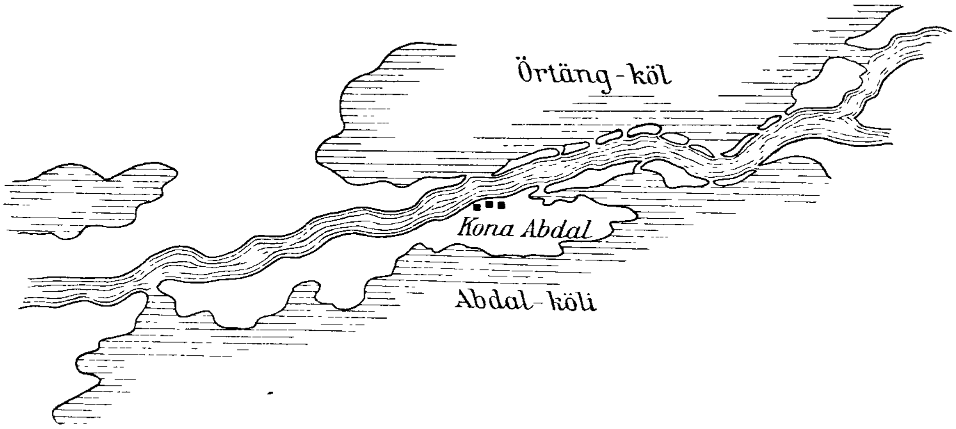


Fig. 130. DISTRIBUTION OF LAND AND WATER AT KONA-ABDAL.

rampart and found ourselves on the broad bosom of the Tarim, immediately opposite to Kona-Abdal and the huts of Kuntschekan Bek. During the latter part of our journey across the lake-basin last mentioned, we had immediately on our left hand, to the south, a long series of tamarisk-mounds crowning the narrow tongue of land between the river and the lake. Still farther south a similar tongue of land parts the river from the Abdal lakes. It is the metamorphosis that is here taking place which led Bogdanovitsch and myself to entertain the view, that the Kara-koschun is travelling back up-stream, though the origination of the new desert lakes has shown that we were only partly right. The extremely curious and unusual distribution of land and water in the district of Kona-Abdal is illustrated in fig. 130. A comparison of this fig. with fig. 127, showing the Kara-buran, would at once lead the observer to put them both down as examples of one and the same phenomenon; in point of actual fact they are however absolutely different. In the Kara-buran the river built up its shore-ramparts through the shallow lake; here on the contrary the river is destroying, at all events in part, the ramparts which it formerly built up, and in that way is giving occasion to the formation of a new lake.

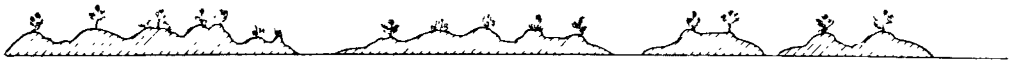


Fig. 131. RAMPART BETWEEN THE ÖRTANG-KOL AND THE TARIM.

The rampart which separates the Örtäng-köl from the Tarim is 2 to 3 m. high, and when seen from the river presents approximately the appearance shown in the annexed illustration (131), the vertical scale in which is however greatly exaggerated. Its mean breadth is 15 to 20 m., though in places it is only one to two meters broad, and in a dozen other places is completely broken through by canals, each only a few meters long, which supply the lake of Örtäng-köl, and the other lakes connected with it, with water from the river, and in this way endeavour to maintain the equilibrium between the different water-surfaces. The road from Kumtschapghan to Jurt-tschapghan leads along this series of long, narrow islands, passing on the way, as I have related above, several large and deep canals, besides numerous shallow ones. The canal opposite to Kona-Abdal is broad, but so shallow, and filled to such an extent with fluviatile sediment, that, high-water though it was, the canoes would scarcely float through it.

Prschevalskij himself noticed what I have already called attention to in my description of the lower Tarim, namely, the river's peculiar tendency to protect and define its bed with ramparts. The annexed series of illustrations will make clear the various stages of its development. Fig. A shows the newly arrived river after it has furrowed a path for itself through the horizontal region. Vegetation speedily shoots up alongside it, and through the retentive and binding power of its roots, exercised in the usual way, it soon initiates the building up of natural ramparts (B). As time goes on, these increase in height (C), and below them the river deposits in its bed increasing quantities of silt and sand, whereby the bottom, and with it the water-level, are alike raised. Eventually, at the high-water season, the level of the river lies considerably higher than the country adjacent. This is the process which I assume to have been followed in the breach that has given access to the new desert lakes. Hence throughout the whole of the system of the lowermost Tarim, at the season of high water, we have the paradoxical condition, that the relatively most elevated parts of the region are the surfaces of the various waters, both flowing and stationary. This calls spontaneously to mind the artificial dykes along the coast of Holland, by which the sea is fenced out. Here however we have natural dykes protecting the river against the desert and concentrating its flood into a single well defined channel

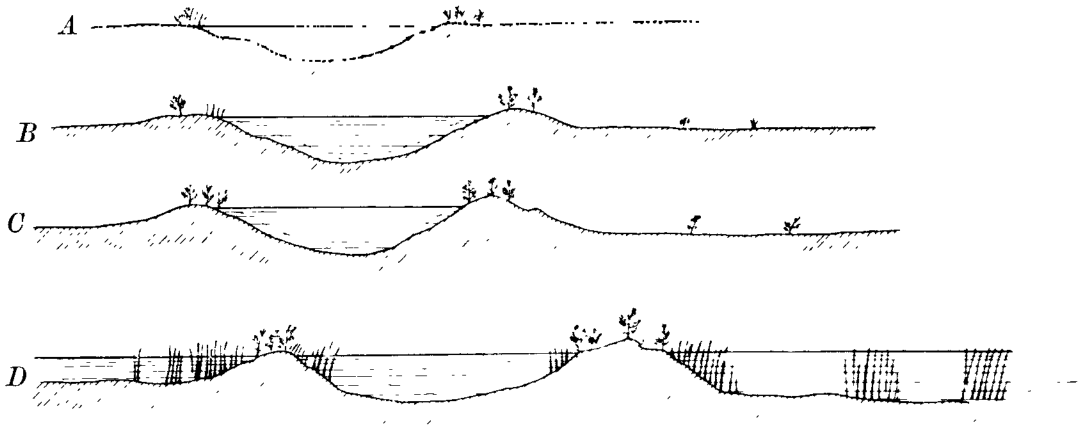


Fig. 132. FORMATION OF RAMPARTS BESIDE THE TARIM.

All the same the process of rampart-building cannot go on indefinitely. As is shown by fig. 131, there are often deep gaps between the tamarisk-mounds. When the high water reaches up to the bottom of one of these, there of necessity a breach is made, and when this has occurred at one or several places, the active erosion that ensues gives rise within a short time to canals. The water that pours through these breaches spreads out on both sides, and soon forms lakes; and in the high-water season these will in all probability maintain themselves *au niveau* with the river (D). A section of this stage, taken through two canals, is shown in fig. 133. It is obvious that a breach of this magnitude in the rampart must give rise to wide-reaching alterations in the map of the region in which it occurs; and I once more emphasise the fact, that any detailed map that is made of this lake-land does not hold good for longer than the particular year and the particular season in which it is made. For although the district around Kona-Abdal in the early days of April (1901) was as shown in fig. 130, the facts which I am about to mention suggest, that in the end of July it must have presented a very different appearance. I have already said, that by the end of June all the side-arms leading to the marginal lakes have to all intents and purposes dried up. At the same period the Örtäng-köl and the Abdal-köli, having their supply cut off, for the most part dry up also, and at best there is only a little water left in the deeper parts. Then the bottom of each lake becomes overgrown with young kamisch, which the Lopliks regard as the best feeding for their sheep.

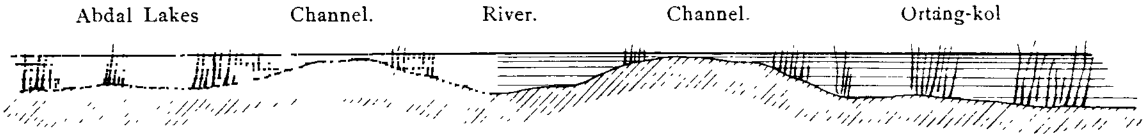


Fig. 133.

It is just in this locality that the river is very deep, and it is unlikely that the lakes anywhere reach depths as great as those which exist in the more deeply excavated parts of the river.

One factor which contributes in an essential manner to the difference of level between the river and those parts of the country adjacent which are destitute of vegetation is the erosive action of the wind, which goes on unceasingly on both sides of the river.

When on 10th March I started from the ruins of Lôu-lan to survey the desert, I sent a large part of the caravan with three Muhamedan attendants by a more westerly route, with instructions to endeavour to reach the point where we made our Camp. No. XXI the year before. One of the three men was with us there on that occasion, and another, Mollah, knew the country around Abdal, I believe, better than any other Loplik. The adventures and wanderings of this party, in their vain attempt to find the camp alluded to, throws in many respects a strong illustrative light upon the results of my own observations set forth above, and in one or two points even supplements them. Hence it will not be an unprofitable digression, if I devote a few lines to their proceedings.

Including two days of rest, they took in all seventeen days to travel from Lôu-lan to Jurt-tschapghan. The first three days were spent in crossing the Desert of Lop and reaching the first of the salt lakes; the year before it had taken us four days to cover the corresponding distance, though along a more westerly route. My men assumed, as I had done, that the lakes they encountered were formed from the Schirge-tschapghan, so that if they wanted to get round them they would have to go to the east. But in that direction they were unable to discover any end to the water; accordingly, after losing three long days trying to get round it in that direction, they were obliged to turn back. Thus their Camp. No. 6 stood in the same spot as No. 3. Then they continued alongside the salt lakes, going this time west. From their seventh camp they turned off, as we subsequently discovered from their tracks and the dead horses we came across, towards the west-north-west, and so, without knowing it, passed quite close to our Camp No. XX of the year 1900. A storm compelled them to encamp in the middle of the sandy desert; but next day, after going about two kilometers farther, they came to some large and beautiful lakes, with perfectly fresh water and an abundance of kamisch. Here they encamped for the rest of the day, the tenth since they started. They took it for granted that these lakes were immediately connected with the newly formed desert lakes, although the water in the latter was so salt, and read in them confirmation of the idea, that all these lakes were proceeding from the Schirge-tschapghan. After that they travelled in two days to the Tokus-tarim, and on the third day reached Muhamede-koschuru, situated somewhere about the spot where the year before we first lighted upon the shepherds. Then, having rested a day with the shepherds, they crossed a stream one meter deep at a ford which the shepherds pointed out to them. On the fifteenth day they travelled to Ujne-aldi-köl, where they found an old house: the name of this lake means the Lake in front of the House. Thence they had two short days' journey to Jurt-tschapghan *vià* the district of Jangi-jer; but at the former place they had to cross a double river-arm, quite recently formed, which issued, they were told, from the Sor-köl (not far from Tschigelik-uj) and, after emptying itself into the lake of Tschajatik-köl, lying immediately north of Jurt-tschapghan, divided and distributed itself between the lake of Örtäng-köl and other new lakes situated farther north.

For one who had himself seen the region in question it was not difficult to interpret this perfectly authentic information. In my men's report two points are of especial interest. The distance between the lakes formed from the Kara-koschun and those formed from the Tokus-tarim was barely half a day's journey, and that a very short one. The men's description showed that the latter extended at least as far to the north as the former. From the point where on 1st April we crossed over the arms with 8 cub.m. in the second to the northern end of the lakes, out of which their water issued, was therefore two stiff days' march. From this it is to be inferred, not only that the Tokus-tarim, and with it the whole of the Kara-köl system, must in the spring of 1901 have been incredibly swollen to have filled such immense depressions, but also that all the lakes situated north of the Kara-koschun and the lowest Tarim must lie in a continuous line; which again points to the existence of an elongated depression parallel to the lowermost Tarim and its terminal lake.

It is also interesting to learn of the existence of a third river-arm, issuing from the district of Tschigelik-uj. Thus not only the courses of the rivers, but the line of the lakes as well, run parallel to the prevailing wind.

On fig. 134 I have indicated the principal lakes, or rather subdivisions of the inter-connected marsh, with I, II, and

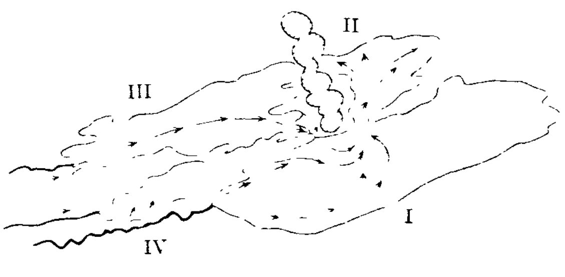


Fig. 134. BASINS OF THE KARA-KOSCHUN.

III. From the statements already made above it will be clear that III lies higher than I, and that II lies lower than I. Hence the flow of the current is as shown by the arrows. Between basin III and basin II there would appear to exist a threshold (indicated by diagonal shading in the fig.), for it is between these two lakes that the greatest difference of level is found; and a connection might easily be established between them along the gullies excavated in the clay soil by the wind, did there not exist a barrier higher than the water-level to prevent it. As basin III is clearly one of vast extent, an active evaporation must ensue from its surface, and a large quantity of water must be lost in the relatively recently moistened ground over which it spreads. Again, seeing that the lake discharges in its turn 8 cub.m. in the second, it is obvious that it must receive a heavy influx from the Tokus-tarim. This has even been estimated at 21 cub.m.; but if the circumstances are the same as those which obtain in the Tarim and Kara-koschun, and in the arms between I and II, then the amount ought to be 37 cub.m. But III is of course much less than I (Kara-koschun), and the evaporation is proportionally less. What relation existed between IV and the other three lakes I do not know; but the probability is that in the spring of 1901 the lake in question emptied itself into the Kara-koschun.

I crossed the zone of land between the lowermost Tarim and the Kara-koschun on the one side and the Astin-tagh on the other by three different routes, all starting from Abdal—in 1896 I went by the Kara-buran, now almost completely dried up, and by the district of Nadschi-bidschin to Tscharklik; in 1900 by the well of Jan-daschkak to Tscharklik; and in 1901 east-south-east to the well of Dunglik. The first-named route I described in *Peterm. Mitt.* With regard to the other two I will add a few words here.

The middle route was traversed on the 6th, 7th, and 8th of April. From Abdal the road led first south-south-west, across the extreme westward extensions of the Abdal lakes, or rather shallow marshes (for they are nothing better), linked together by small shallow canals. They are supplied exclusively from the east, so that the water enters them from the opposite quarter to that from which the Tarim enters them. Their bottom is treacherous in the extreme; for here the natives of Abdal had just lost three horses literally »drowned» in the ooze, and it was only by dint of constructing a temporary bridge of sheaves of kamisch and tamarisks that we were able to get our camels over.

These quagmires are succeeded by a belt of perfectly barren and naked schor, 2$^1/_2$ to 3 km. broad—dry, hard, saliferous sedimentary matter, which was laid down in the lake, for at that place the lake extends that far. The old shore-line appears to be marked by a thin belt of tamarisks, long dead and withered, but still standding on their mounds. Here there is a broad shallow watercourse, called Mijan-ajaghi, down which the rain-torrents sometimes stream into the lake. Coming from Mijan, this watercourse continues on to Jaruk (pron. Jajuk) on the Tarim, though the water seldom gets down as far as that. Even then there was a tiny rill of muddy red water, excessively salt, trickling down it. South-west of Mijan-ajaghi the steppe begins again, and is dotted over with kamisch, jantak, and other desert plants, as well as with numerous tamarisks, dead and living, perched on the usual mounds. At the first line of tamarisk-mounds we distinctly felt the beginning of the ascent towards the foot of the mountains. Thus the former strip of shore beside the flat-bottomed lake is here not more than 3 km. broad. At Mijan-ajaghi there is nothing to suggest a former lake-bottom; so that it is not surprising to find that the belt of tamarisks nearest the lake and the Tarim were dead, while those which grew twice and three times the distance away were still alive and vigorous. The first belt owed its existence to the presence of the lake; those farther away have nothing whatever to do with either it or its basin: they would have established themselves where they now stand even though no lake had ever existed near them. It is the recession of the lake which has caused the first belt to wither and die; whereas the latter are maintained in vigour by the chance rains of spring and summer, or in general by the moisture from the adjacent mountains.

In this steppe too, which is known as Sariklik, there occur, widely scattered, small rudimentary dunes, forming a belt about one kilometer broad; but there is no drift-sand whatever to be found anywhere along this route. The reason of the sand having accumulated just where it is, is that the vegetation has built up a hindrance in its path. In the barren tracts situated farther east there is, on the other hand, no sand.

The first little group of small, gnarled poplars we came to is called Turdu Nias-kemi-tschapghan-toghrak. Another group farther to the south-west is called Pakalama-toghrak. Between the two there are a great number of tamarisks growing on high mounds. And this character is preserved all the way to Töllak Kullu, where there is a little clay hut marking an *örtäng*, or »station», on the road to Tscharklik. In a deep ravine, buried under thick reeds, there is a salt spring, and when we passed, there was still actually a little ice remaining in it. At the side of the ravine poplars were growing amongst the tamarisk-mounds.

Modschuk-toghrak marks the northern border of the zone of vegetation, which thus constitutes but a narrow strip along the foot of the Astin-tagh, though it extends a long way both east and west. Westwards we encountered its continuation on the way to Andere and eastwards at Dunglik (see below). North of this belt of vegetation is schor, south of it, and stretching all the way to the foot of the mountains, hard barren *saj* (here called ***kakir***), intermingled with coarse grey sand and some gravel. By far the greater part of the vegetation consists of kamisch, tamarisks, and toghraks, the last however often in the form of ***kötäk***. Their mounds reached 4 to 6 m. in altitude, and one of the biggest was called Karaul-dung. To the south-east we observed the glen of Toghrak-tschap emerging from the mountains, and east of it saw, though but faintly because of the hazy atmosphere, the glen known as Mijan-baschi, whence issues the brook above mentioned that waters the oasis of Mijan, a link in the belt of vegetation. Other names in this locality are Ahmed-kuduk, a well, and Jan-daschkak, the second station of the route. On the third day's march, which clung all the way to the southern margin of the vegetation, we passed the eroded torrent that issues from Toghrak-tschap, the real Jan-daschkak. At Tes-jatghan we struck a track coming from Mijan and Tschimen. About one kilometer north of that point is the spring called Tschong-bulak. Other names in this quarter are Kade-tiklaghan-dung, Kara-schipang, Tatran, and Dung-aghil. Immediately west of the last-named we crossed the first canals that are drawn from the Tscharklik-su, and soon after that came to the little *chef-lieu* of the Kara-koschun region, namely Tscharklik, where a Chinese amban resides.

With respect to the most easterly of my three routes through the districts on the southern shore of the Kara-koschun, there is not much to say, for there can hardly exist anywhere on the earth a more monotonous and more desolate region than this. The route led from Jurt-tschapghan to Dunglik. But as the lakes of Abdal, which are known as Usun-köl, stretch some distance west of Jurt-tschapghan, it is necessary also in the month of April to make a wide detour in order to get round them; but on the occasion I am speaking of, the 30th June, we were able to take a short cut by traversing a bridge thrown across at a narrow neck between two of the lakes. There is an even shorter cut still, lying yet farther to the east; but it can only be used for about two months in the summer counting from the beginning of July, when the lakes dry up completely, though it can also be followed in the winter when there is ice. For my own part I preferred to travel by water, and did it at night, proceeding from Jurt-tschapghan to Tusun-tschapghan, and then crossing over the Ifane Kullu-köl, entered the southern waterway by which I journeyed in April. Everywhere the lakes had diminished in area and were smaller in circuit; in the Sate-köl the depth was only $^1/_2$ to 1 dm., and the water was perceptibly salt. For a good distance my canoe was dragged like a sleigh through the ooze, until we at length reached Jol-arelisch, where the road divides, one branch going east to Tung-chuan, the other east-south-east to Dunglik, Tschimen and Tsajdam. After that for the rest of the way to Dunglik the ground is, so far as one can judge by the eye, perfectly level, and without a trace of vegetation. Altogether we saw only three fragments of tamarisk-roots, all no doubt old drift-wood; at no place did we discover rooted tamarisks or even signs of their mounds, still less any trace of the »old forest» mentioned by Littledale. Our only supply of fuel was the dry reeds which two or three of the Lopliks brought in from the adjacent marsh. We also had to fetch our drinking-water from a long way out in the Kara-koschun.

Although the track is everywhere distinct, sign-posts are nevertheless erected at intervals. We crossed a few torrents, not exceeding $1^1/_2$ m. in depth, some of them excavated by the rain-water, in which case they were dry, while others issued from springs situated within the zone of vegetation. Two of the latter class, Tscholaki-mijani and Atschik-bulak, contained even then slight traces of intensely salt water. This hard, lumpy, but on the whole flat, schor ascended a little towards the south, as was evident when we turned and looked in the opposite direction: the marsh of Kara-koschun had the appearance of a faint dark line, and its kamisch-fields appeared to hover, as it were, in the air above the horizon.

At Dunglik—though this name is applied generally to the vegetation zone as a whole because of the tamarisk-mounds (*dung*)—there is a well 3.29 m. deep, with water that is drinkable at a pinch. Its temperature was 14°.3 C., the temperature of the air being 40° C. Here a little station-house was erected in 1896. The vegetation consisted of the usual varieties, except that toghraks were absent. The zone is much narrower here than farther west at Tscharklik. It would however be a mistake to jump to the conclusion, that these mounds, and the bushes which crown them, grew originally on the shore of a former lake, the outline of which is indicated by the zone of vegetation as a whole, because the latter is continued, as I have said, a long way west of Tschertschen, where there is not the slightest indication of the former existence of lakes.

# THE DESERT OF LOP

# CHAPTER XVI.

## ACROSS THE DESERT FROM ALTMISCH-BULAK.

The region traversed by the lowest part of the Tarim, in which the hydrographical system of East Turkestan succumbs in its desperate struggle against the drift-sand and the arid climate, constitutes one of the most dreary and most barren deserts of the earth. The only relief to its depressing monotony is afforded by the bend which the river makes to the south-east, south, and east-north-east. The presence of the water has resulted there in a belt of vegetation, though of no great breadth, springing up along the banks of the river. Itself forming but one link in the chain of deserts which, as Peschel justly observes, traverse the Old World like a long dried-up river-bed, the East Turkestan desert is divisible into several distinct parts, either separated from one another by rivers or else merging into one another. If we regard the »ocean of sand» which is bordered on the north by the arc of the Jarkent-darja and Tarim, and which occupies by far the greater part of the area of the elliptical basin of East Turkestan — the only exceptions being the border regions and the actual course of the river — if we regard this as a unity in itself, then the most appropriate name for it is Takla-makan. For practical purposes I divide this great desert into three sections, and to the section in the west, bordered by the Jarkent-darja and the Chotan-darja, I apply the name of the Takla-makan proper. The middle division is the Desert of Kerija, or perhaps more correctly Desert of the Kerija-darja, bordered on the west by the Chotan-darja and on the north by the Tarim. But to draw a dividing-line on the east between this and the third division, which I would distinguish as the Desert of Tschertschen, is not practicable, nor, strictly speaking, is it necessary. As a provisional boundary one may take the meridian which passes through the intersection of the Kara-muran and the *astin-jol;* north, east, and south the Desert of Tschertschen is sharply defined by the Tarim and the Tschertschen-darja. The zone of desert which lies between the Kuruk-tagh and the Astin-tagh is divided naturally by the Kara-koschun and the sand-free part of the desert which forms the east-north-east continuation of this marsh. In shape this belt of desert is rectangular, and as the natural boundary lies diagonally to it, its two halves form each a sharply pointed triangle. Of these the north-western triangle is bordered on the north by the Kuruk-tagh, on the west by the Kontsche-darja, the Ilek, and the lakes of Avullu-köl, Kara-köl, Tajek-köl, and Arka-köl, the lower Ilek, and the Tarim, and on the south by the lowest course of the Tarim and the Kara-koschun. The boundaries of the south-east half are, on the north the Kara-koschun and the Kuruk-tagh, on the east the Chara-nor and the Tan-ho (the river of Sa-tscheo), and on the south the Anambaruin-ula and the Astin-tagh. Prschevalskij bestowed upon the latter division the name of Kum-tagh, a name I confess I never heard used in that connection; moreover it is a very unlikely name, because it means »Sand Mountain», i. e. a mountain covered with sand, as, for example, the Tekija-tagh. Tschöl-tagh means the Desert Mountains, Kuruk-tagh the Dry Mountains, Altin-tagh the Gold Mountains, and so by analogy Kum-tagh would mean the Sand Mountains. Sand-dunes which rise to the altitude of hills are called Tagh-kum, where the syllable *kum*, meaning »sand» or »sandy desert», is the emphatic part of the compound.

But it is the Desert of Lop with which we are now about to deal. This desert I have crossed from north to south along two different routes, both however traversing the middle of it. Both started from Altmisch-bulak and terminated at the northern shore of the Kara-koschun, but the 1900 route lay farther to the west than the 1901 route. Although the distance between these diverging routes is not particularly great, they nevertheless traverse dissimilar parts of the desert, so that it will be desirable to describe each of them in turn, especially as the crossing in 1901 was accompanied by a mathematical survey, which will form the basis of important conclusions.

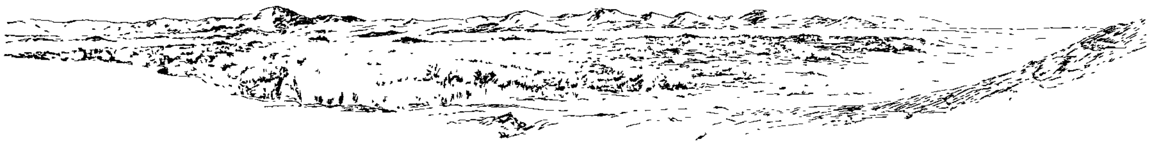
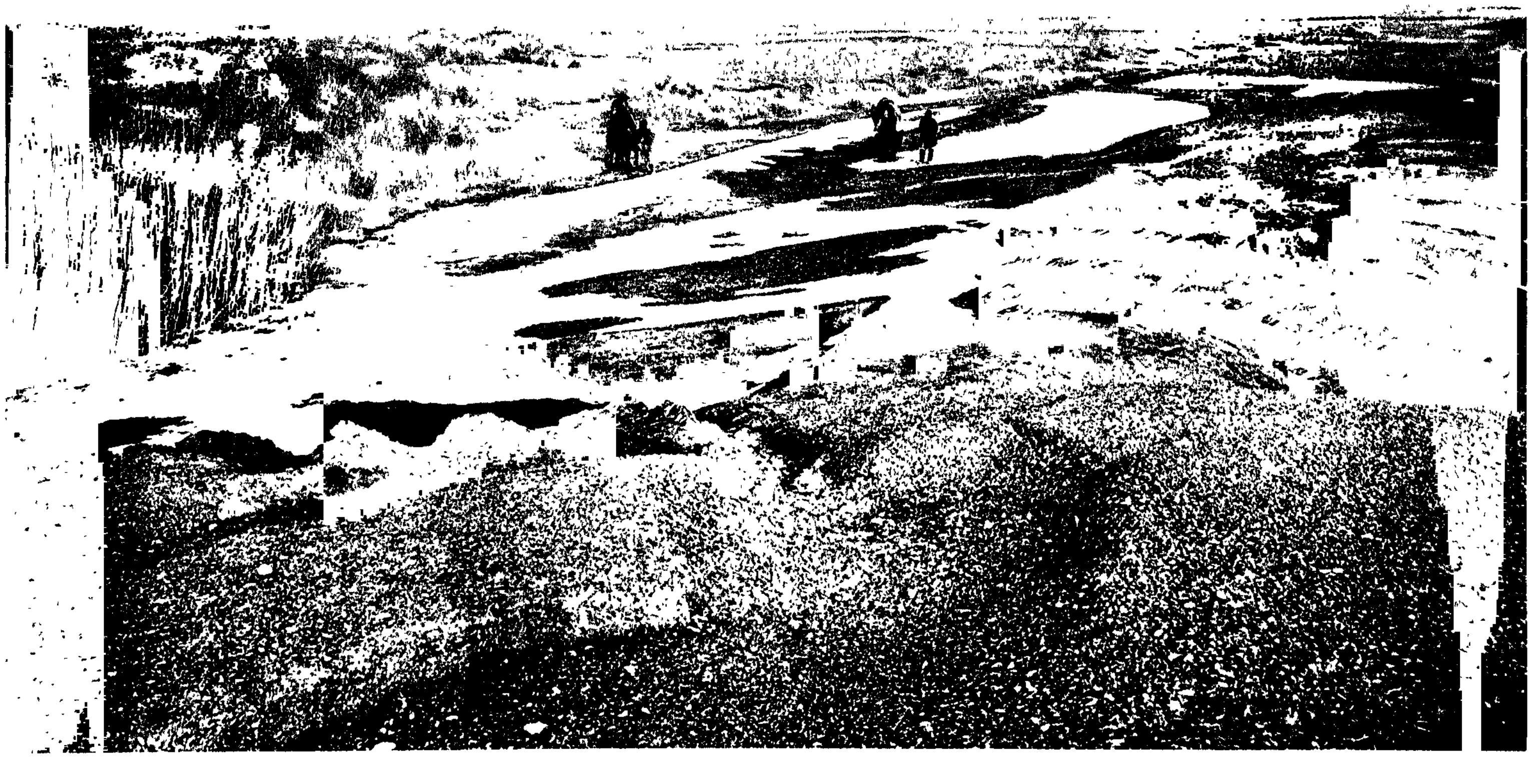


Fig. 135. VIEW OF ALTMISCH-BULAK, THE OASIS AT THE FOOT OF THE KURUK-TAGH LOOKING NE.

When I left Altmisch-bulak on 27th March 1900 the ice-sheet was still a foot thick, but before we got a couple of hundred meters from the oasis the brook came to an end in the gently sloping channel that winds lazily down to the desert. It is shut in by bordering hills, 10 m. high at first, vertical on the concave sides of the gentle curves, but elsewhere rounded. The hills themselves consist of sharp-edged, dark green schists, with a dip of 49° S. 30° E. near to the oasis, but two or three kilometers lower down a dip of 17° S. 30° E., while on the little rocky threshold, where the spring itself is situated the dip is 58° S. 30° E. That is to say, the rocks lie increasingly steeper from south to north. In some places they crop out like thresholds in the bed of the torrent, and there they are rounded. The bottom of the torrent is hard, strewn with fine gravel and coarse sand, and sparsely dotted over with various scrubby steppe plants. The dimensions of this watercourse suggest that the catchment area of the Kuruk-tagh which drains through it cannot be small; for the eroded bed of the Altmisch-bulak stream is the biggest and most deeply excavated of any in this part of the Kuruk-tagh.

The little threshold immediately south of the spring forces the torrent to deviate from the east-south-east to the south-east and south-south-east. The space

Pl. 19.



*Ljustr A B Lagrelius & Westphal*

SOUTHERN EDGE OF ALTMISCH-BULAK. ICE-SHEETS IN BED OF STREAM.

between the edges of the excavated channel and the bordering hills is like a magnificent highway. Gradually the track widens out, the gravel decreases in quantity and grows smaller in size; and finally the glen opens out upon hard *saj*, studded with »tables» (*horst*) and pillars of clay, pretty high and frequently standing isolated, with a steep descent on the south. The dip of the clay strata is one or two degrees towards the south-south-east. Once more the torrent contracts; but there we turned away from it leaving it on our left, and while we pushed on due south, the water-course disappeared towards the south-south-east. Very soon we came to another torrent, farther west, and crossed over it at its lowest extremity; it was no doubt only a branch of the brook of Altmisch-bulak. The ground between these two torrents consisted of salt horizontally deposited, as hard as stone and coated with dust, though immediately beneath the surface it was pure and uncontaminated. This more westerly arm became lost amongst yet other isolated »tables» of clay. After that we traversed

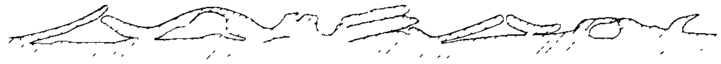


Fig. 136.

an expanse of schor of the usual character, as flat as the ocean, dry and hard, though the surface was uncomfortably rough from the arched elevations, resembling blisters and ribbings, with which it was diversified, and which were frequently split and cracked. It need hardly be said that this saliferous soil is fatal to every form of plant-life. To the west we saw, a pretty long way off, the detritus slope sinking gently down towards the desert, together with its upper range of clay hills. On our left, i. e. to the east, we had, at the distance of a couple of hundred meters, a chain of big clay hills. The surface was scored by two or three small rain-water gullies, one meter deep, running from east-north-east to west-south-west; but for all that it was impossible to tell in which direction the ground sloped. Shortly afterwards we entered amongst the ordinary jardangs, that is to say the flat clay desert, furrowed by the gullies which the wind erodes from north-north-east to south-south-west. The ridges between the gullies are 2 to 3 m. high, but decrease in altitude even in the short distance that remained to Camp No. XV. No trace of any old river-bed was here discernible, and there was a total absence of dead forest; the only vegetable products we found were two or three fragments of poplar or tamarisk wood in one place, and a couple of ancient mounds at Camp No. XV. No doubt we were in a part of the basin where water stood in ancient times, so that forest-trees had been unable to spring up there. Another sign of this was the presence, though in no great numbers, of mollusc shells.

Here too, as farther west, it was possible to distinguish three levels or »stories» in the excavated parts of the desert — the lowest layer, the bottom of the gully along which we were marching, is fenced in by the chains of jardangs, which make »storey» no. 2. The third storey, which occurs but seldom, though in some places there are large and striking remains of it still surviving, rises 15 to 20 m. above the lowest level. Its domes, pyramids, and eminences are visible a good long way off, and bear a bewildering likeness to the ruins of human habitations.

They are built up of a more reddish variety of clay; but even in their case also the horizontal position is extraordinarily distinct. It is in the east that they are chiefly developed, and I have no doubt that in that direction they are connected with the deeply excavated jardangs we travelled through in February 1901.

On the accompanying illustration (fig. 138) the uppermost layer is indicated by the widespaced dotted lines, the middle layer by dotted lines placed closer together, while the white portions represent the bottom layer. In this part of the desert, it may in general be said, that approximately one-half of the area is occupied by gullies, the other half by the usual jardangs, or the middle layer, upon which the topmost layer rests as upon a pediment. You can sometimes ride for long distances beside one and the same clay ridge, that is in the same unbroken gully; but generally these parallel elevations are interrupted at short intervals. Our line of march was entirely determined by their direction towards the south-south-west, and it was very seldom that we encountered any low threshold that required to be crossed over. From the top of one of the 15 m. high clay eminences, we were able to make out the gullies running to an immense distance towards the south-south-west; but, on the other hand, there was no sand. In the bottom of one gully we noticed patches of sand an inch thick, but nowhere were there even the beginnings of a dune-formation.

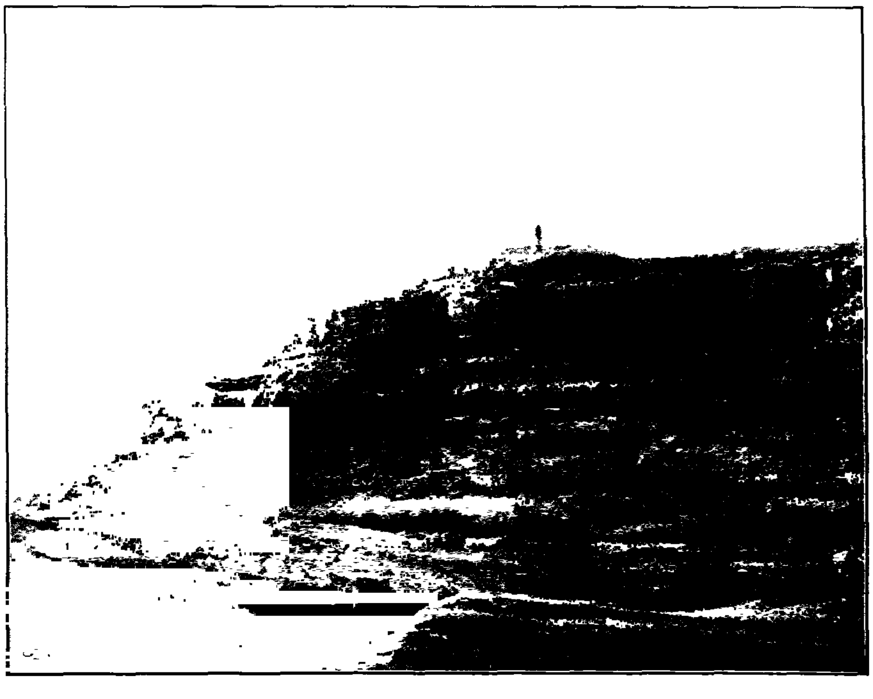


Fig. 137. A 15 M. HIGH CLAY EMINENCE OR HIGHEST STOREY OF JARDANG.

Only once did we see any old kamisch stubble. I have already observed, that in the northern part of the Desert of Lop the vegetation, i. e. old, dead forest, decreases in quantity from west to east precisely in the same way as it does in the Kara-koschun. In the latter locality the last poplars are found at Tschigelik-uj, and south and east of that point there are none but young and tender trees, and even they are remarkably rare. In the Kara-koschun itself, the reeds decrease towards the east, until four short days' journey north-east of Kum-tschapghan they thin out rapidly, and soon after come to an end altogether. Beside the Kuruk-darja we found living toghraks at Jing-pen; then dead forest, the trees still standing upright, at first any abundance of it, though afterwards it diminished in quantity. The same remark applies to the old tamarisk and kamisch vegetation. This is however only true of the extreme north of the desert; though it is clear that it was once covered by the waters of the lake. The reason the vegetation decreases, and the reason why it is entirely wanting in the bay-like prolongation of the desert towards the east, which we crossed over in February 1901, is no doubt this, that these parts of the former lake were the first to dry up, coupled with the fact that the water surfaces were then more connected. As we shall soon see, the relations south-west were quite different.

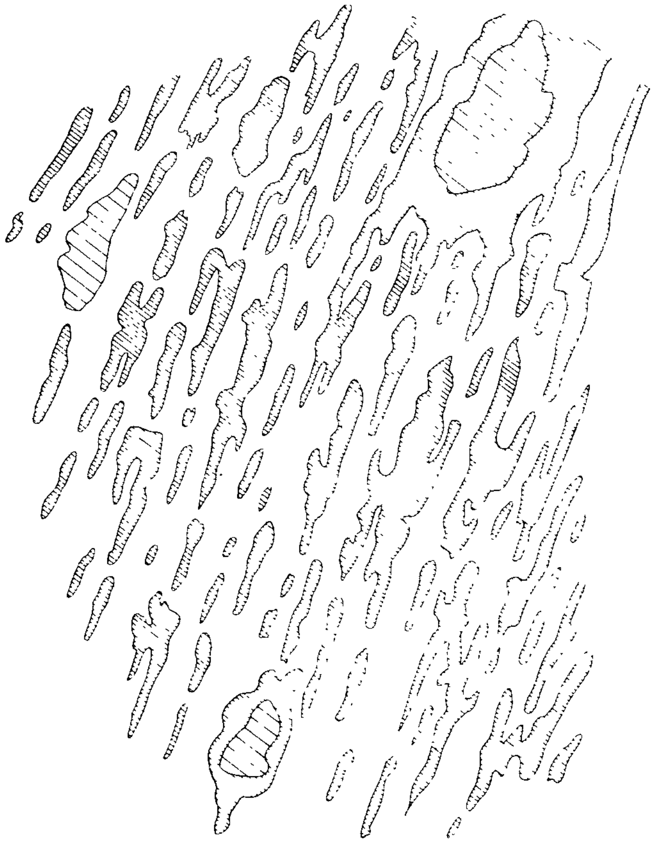


Fig. 138. THE JARDANG DESERT.

In the course of the 22 km. that we traversed on the 28th March the desert underwent changes of some magnitude, both in relief and in respect of its other characteristics. The south-south-west direction became altered, and of necessity, to S. 41° W., owing to the wind-eroded gullies assuming that direction. Their parallelism was perhaps a little less pronounced than is was during the previous day's march, though that idea may possibly have been suggested by the fact that the jardangs were shorter, and that it was seldom possible to keep for so long together to the same long gully. In places the jardangs approached so close together that it was as much as the camels could do to get between them. Here we were still able to distinguish the three different stories, indeed we could sometimes even make out four, although the fourth, which does not exceed 10 m. in height, is rudimentary and rare. Towards the close of the day's march the separate layers became more and more fused together, and it became increasingly difficult to distinguish the step-like divisions between them. At the same time the jardangs were more widely separated and grew smaller in size, the desert itself more open, and the gullies less energetically excavated.

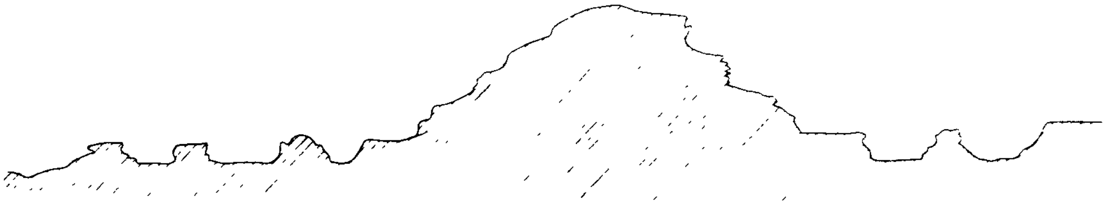


Fig. 139. SHOWING THE HIGHEST KIND OF JARDANG.

Although the sand continued to be extremely little in quantity, nevertheless it increased as we advanced south, and in the vicinity of Camp No. XV we perceived a couple of tiny dunes to the south-east and south-south-east, though all day not one dune in the proper sense of the term. Occasionally there was a little sand, a decimeter thick, in the gullies, and in one place a pretty large space was coated with a similar thin layer. Looking north-west we could not help noticing the slow, gentle slope of the saj or detritus-slope stretching from the foot of the mountains towards the clay desert. It is plain that Lop-nor once sent out a large bay to the north-east, namely that which we crossed over in February 1901. This I infer, not only from the direction in which the saj extends, but also from the fact that from Altmisch-bulak the clay desert can be seen continuing a long way towards the east, though swinging round to the north-east as it were along a once convex shore.

But the most striking change is that the vegetation once more puts in an appearance, and is indeed in places particularly luxuriant. First come a few very ancient tamarisks, dried up and brittle as glass, standing for the most part on high mounds, though sometimes also on the level ground. They appeared in greatest quantity on the left of our route, that is to the south-east. The stratification of the clay is just as distinct in these mounds as elsewhere in the desert, a proof that they were carved out of the general mass by the wind, and did not grow on what was originally the level ground. In these mounds there would appear to be several varieties of structure; but one law is common to them all, namely that their skeleton or framework is always composed of the roots of the bushes, and it is these roots which hold them together. In certain directions, and over pretty extensive areas, dead reeds and sedge are very plentiful. Next we threaded a belt of toghrak forest, the trees standing upright and being often pretty coarse-stemmed; they stretch in two directions, S. 62° E. and S. 60° W., meeting at a common point, and undoubtedly mark a portion of the former lake-shore. Everything points to the fact that the vegetation which formerly existed here was especially thick and vigorous. By far the greater part of it consisted of scrubby kamisch and tamarisks, amongst which the toghraks formed small groves. All the same there can be little doubt that large areas of this great kamisch-field were once under water, and that the poplar-groves then stood on the islands and promontories. To both features we have a parallel at the present time in the Kara-köl and several other lakes. Another proof of the former extension of the lake in this direction is the great quantity of mollusc-shells which we observed all day, a far greater quantity than on the day before. Fragments of hard, burnt clay pottery, red and purple, were now so common that we no longer paid any attention to them; we came across them incessantly, but it was seldom that they exceeded 2 dm. across. They constituted irrefragable evidence of the presence of human beings in that part of the desert, and at Camp No. XVI we made the interesting discovery of some ruins, which are described towards the end of this present volume.

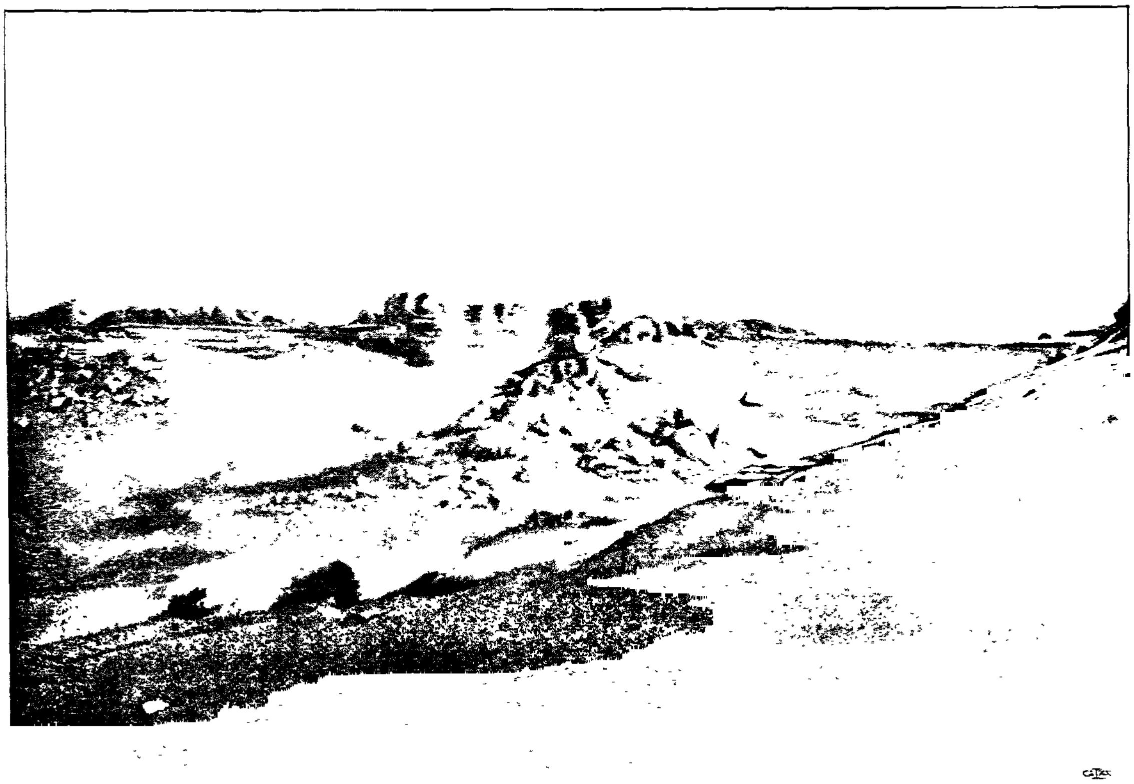


Fig. 140. OLD BED OF THE TARIM IN THE MIDDLE OF THE DESERT OF LOP.

From this place, the ancient Lou-lan, I attempted on the 29th March to proceed south-south-west, but found it impossible owing to the jardangs, and had therefore to keep to the south-west. We were only able to win a little ground to the east by going through the gaps which occurred at intervals in the ridges. For some distance after leaving the camp beside the ruins we followed a gully, sculptured with great distinctness and resembling a river-bed, for a number of toghraks were growing on its bordering terraces on both sides. Yet as the ground on the other side of these groups of trees was just as low-lying as the bottom of the trench we were travelling in, the terraces may equally well have been islands in the former lake, and the gully between them, which ran north-east to south-west, may equally well have been hollowed out by the wind.

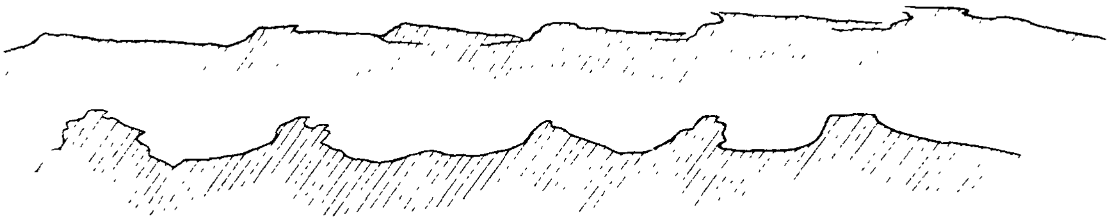


Fig. 141. LOW JARDANGS.

During this day's march the appearance of the desert changed again. There was toghrak forest everywhere, the trees occurring always in small scattered groups, or a few grey trunks together, all without branches. The tamarisks and kamisch-fields varied in both thickness and extent of distribution. The mounds were generally 3 to 4 m. high, seldom 5 m. The drift-sand gradually increased in quantity, forming small rudimentary dunes, though seldom more than one meter in height. But this, the first belt of sand we encountered, soon came to an end. After that, when it began again, it continually increased in quantity, and as it did so the jardangs decreased. Indeed in the vicinity of the first belt of sand they were already sparse, and only occurred at intervals amongst the dunes; and they were seldom more than one meter high. At the beginning of the second belt of sand the stratum of the clay terrace which I have called storey no. 2 was rare, and stunted, and consisted of extremely small, short, and ill formed ridges. In consequence the desert grew more open, and there was nothing to hinder the view. Storey no 1, or the clay base upon which the jardangs stand, is itself seriously attacked by the wind, being already grooved from north-east to south-west, but the jardangs so formed are only one foot high. All the same they form very serious obstacles in the path of the traveller, and would make a journey to the south-east extremely toilsome. In one depression or hollow, 6 m. deep, and stretching east and west, we found in our path an especially large accumulation of sand. But the wind-erosion had nothing to do with the hollow: it had manifestly been scooped out by running water, and was the relict of some river-arm, a memorial of the Tarim's restless wanderings between the northern and the southern depressions of the Desert of Lop. We had already discovered similar river-beds on the north-west shore of the Kara-koschun; and the Tokus-tarim too belongs to the same chain of parallel river-beds, which one after the other have carried either the entire river or at any rate a part of it.

About one-half of the area to the south-west of this river-bed was occupied by dune-sand; the other half consisted of bare wind-furrowed clay, with the thinnest scattering of vegetation. The first living vegetation we came across in this direction consisted of a number of tamarisks, rather small and languishing, growing amongst low dunes. These again appeared to form a strip stretching from west to east, or rather perhaps from west-south-west to east-north-east, and consequently parallel to some primeval depression of the surface. In a pit or hollow, some meters deep, near these tamarisks it looked as though the ground-water could soon be reached by digging, and indeed it must have been pretty near the surface, otherwise the tamarisks would not have been able to keep alive. Throughout the day the mollusc shells were very numerous.

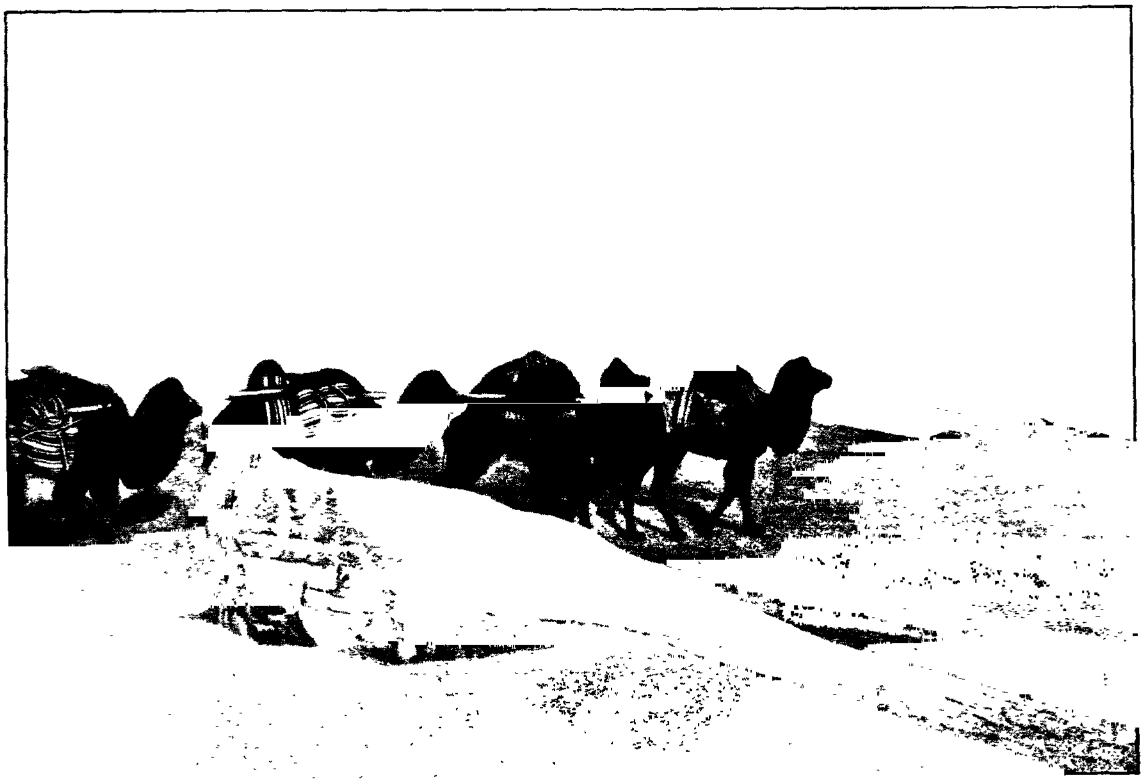


Fig. 142. PART OF A JARDANG SURROUNDED BY SAND.

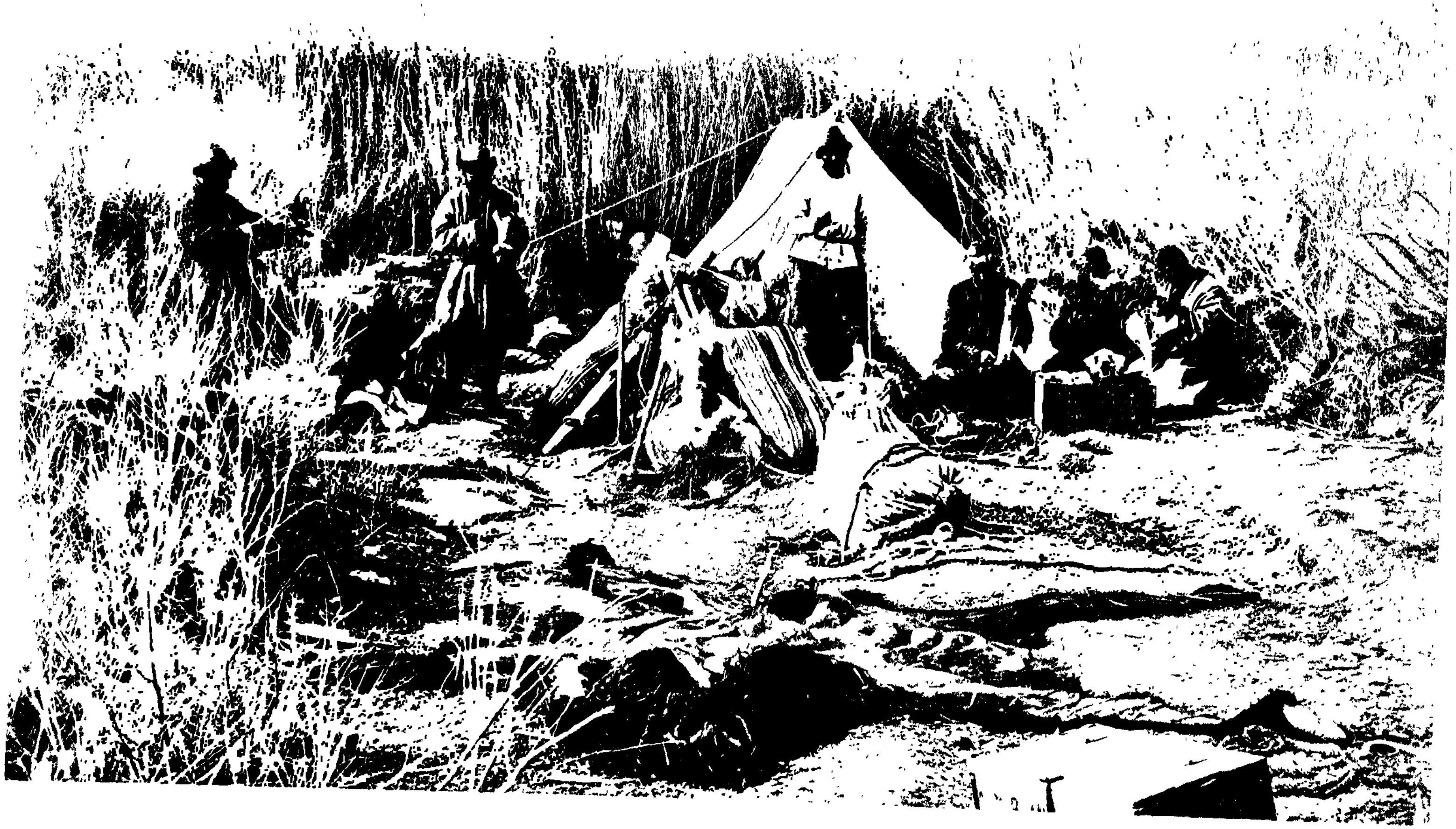
On the 30th March we were able to travel 20 km. without hindrance towards the S. 16° W. What few jardangs there were were rudimentary, and we were able to avoid them. The sand however became practically continuous, although at intervals fragments of the edges of the jardangs stuck out of it. There are also here bajirs of the same kind as those in the Desert of Tschertschen, although of course in miniature. As a rule they are only 20 to 50 m. long and a dozen meters or so broad, and stretch south-west and south-south-west; this however facilitated our march. The direction in which they lie was unlooked for; for, the prevailing winds blowing from the north-east and east-north-east, the dunes turn their steep faces towards the south-west and west-south-west, so that one would have expected the bajirs to run from the north-west to the south-east or from the north-north-west to the south-south-east. Their position in the Desert of Tschertschen is explicable by the decrease in the quantity of the sand from north to south; but here that explanation no longer holds, for the sand increases towards the south-west and south. This notwithstanding, these small bajirs obey the law of general parallelism, and appear therefore to bear some relation to the wind, or rather to the relief of the clay desert and the wind combined.

The sand has no doubt been prevented from accumulating over certain areas by the gullies which existed prior to its advent, and these areas are surrounded by dunes. Nevertheless I have been unable to hit upon the precise cause of the relation to which I have alluded. At all events the jardangs in this part of the desert are quite insignificant, though their step-like terrace formation comes to light again in the bajirs. The bottom of each bajir is covered with a layer of fine dust an inch thick, excessively soft, powdery, and perfectly dry. It requires but a very slight puff of wind to set it in motion, so that it appears to settle afresh after every storm, only to be driven on farther by the next storm that comes. Possibly the presence of these bajirs depends solely upon trifling differences in the surface relations, and they indicate nothing more than places which are avoided by the drift-sand. At all events they do not owe their existence to the same cause as the bajirs of the Desert of Tschertschen, and their outlines are less regularly drawn. Their regional distribution is also very irregular. Sometimes we would travel a good distance without encountering anything but sand, then again the bajirs would lie close together. Farther south the bottom of some of them was overgrown with kamisch, of course withered and cut down to stubble centuries ago; it lay over towards the south-west, as though it had been brushed down in that direction. This kamisch would hardly seem likely to have anything to do with the origination of the bajirs, for dead vegetation is rather a hindrance to the sand and more likely to initiate the formation of dunes than of bajirs. Several of these small bajirs are however beginning to fill up with sand; in which respect again they are very different from the large bajirs in the northern part of the Desert of Tschertschen. Upon climbing to the summit of one of the higher dunes, we saw that the sand grew higher and higher towards the south-west, but lower and lower towards the east and south-east; and indeed on our more easterly route in 1901 we encountered only very small quantities of sand.

Towards the close of the day's march the survivals of ancient vegetation became rarer and rarer; and although the mollusc shells still occurred, they were fewer than formerly. Of tamarisks we saw only two living bushes, both small.

On the 31st March the desert grew more desolate, and the sand higher in the direction in which we were travelling. The bottom of the bajirs was now covered with sharp-edged crystals of gypsum, agglomerated together, and with tiny cylinders of sand and lime cemented together, which had been formed round the stalks of reeds. Pieces of dry timber were excessively rare, and of living vegetation only two small tamarisks; and apart from these not a single wind-driven leaf. It would have been useless to dig for water, the ground was much too dry. Thus the farther we advanced southwards, away from the northern depression which once contained the lake of Lop-nor, the fewer grew the remains of the ancient poplar forests, and of the tamarisk and kamisch steppe. The day's march brought to our notice the trunk of only one solitary poplar.

*Limnæa* shells were still abundant everywhere, though mostly in the shape of thin fragments scattered amongst the sand; they seemed to have been transported thither by the wind from farther north. The sand was now rather heavy, although the dunes seldom exceeded 6 m. in height. Yet it is not evenly distributed, but appears to be arranged in huge waves, so that in some places it is heaped up higher



*Ljustr. A. B. Lagrelius & Westphal*

CAMP AMONGST THICKETS OF ALTMISCH-BULAK. MEN CLEANING SKELETON OF WILD CAMEL.

than in others. In the latter the dunes are seldom more than 3 m. high, and the bajirs are bigger. The steep slopes are here turned to the west-south-west and the west, suggesting that the course of the prevailing wind forms a curve, being more northerly in the north and more easterly in the south; and this inference is further supported by the situation of the jardangs. In the north-east part of the desert the wind-eroded gullies stretch from north-north-east to south-south-west, sometimes even from north to south; here however they extend from north-east to south-west or even from east-north-east to west-south-west. Yet the sand is present in such preponderance that the jardangs obtrude themselves but little, their edges projecting only here and there; yet they often resemble detached table-like masses. Mounds occur also, though but seldom. The floor of the bajirs was not quite so level as it had been hitherto, but was slightly undulating, and sloped very gently upwards towards the south-west, though this does not of course imply that the desert as a whole rises in the same direction. The rise in each bajir is merely caused by the local undulation of that part of the desert, and no doubt this is also the cause, not only of the formation of the bajirs, but also of the unequal distribution of the sand. The reason the desert is less level here than farther north is that this locality forms a threshold or dividing-ridge between two basins, and has not been under water for a very long period, though because of its varying consistency it has been attacked by the wind with varying degrees of effect. We no longer saw any dry toghrak wood, and the fragments of tamarisk that we passed occasionally were perfectly loose and separate, that is they were never rooted. Curiously enough, we again saw a couple of living tamarisks. Evidently new-comers, they were standing in the very lowest depressions, and if they did possess mounds, the mounds were certainly low. The ground all round them was every bit as barren and arid as elsewhere.

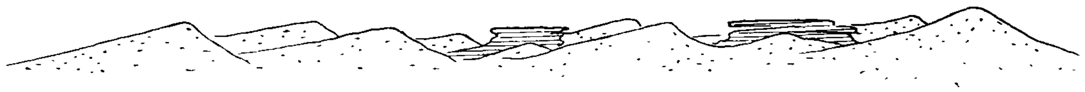


Fig. 143. JARDANGS IN THE SAND.

After that the desert all the way to the northern shore of the newly formed lakes presented the features which I have already described. The general conclusions that admit of being drawn from this crossing of the desert will be discussed in connection with the second crossing farther to the east. This I will now proceed to describe.

The short distance from Altmisch-bulak to the ruins of Lôu-lan was traversed by a different route from that taken before. Leaving the spring of 1st March 1901, we directed our steps towards the south-west, and then towards the south, and thus evaded entirely the great eroded torrent of Altmisch-bulak. This latter lay to the east of us, while to the west we had the route from the desert to the springs and the low spur of the mountains which we crossed over before. The surface was hard and broken, and strewn with gravel, and there were small knobs of much weathered greenstone sticking up in several places. For a time we followed an eroded torrent, running south-south-west and inclosed between ridges of greenstone, 3 to 6 m. high, and often forming perpendicular sides to the torrent. This however soon came to an end, and we once more emerged into the open country.

The reason I selected this route was that one of my men had by the purest chance hit upon a spring surrounded by vegetation, an oasis in fact, and so well concealed by the lie of the ground that Abdu Rehim, my hunter guide from Singer, had never observed it. No matter from what direction this little oasis is approached, its presence cannot be perceived until you get quite close upon it. On the other hand Abdu Rehim pointed out to me another spring, lying south-west of Altmisch-bulak, and showing its yellow kamisch-fields a little way off. It was however at that time dry; in fact it is only in seasons of good rain and snow-fall that it does yield water.

In point of area the newly discovered oasis was barely one-tenth of that of Altmisch-bulak, and its vegetation was less abundant and less luxuriant. The kamisch was thinner, the tamarisk-mounds drier, but the bushes had thick, strong stems. The surface fell away in every direction except to the north, where the barren gravelly ground approached close up to the vegetation of the oasis. On every other side there was a steep edge overhanging the barren surface a couple of meters below. As the vicinity was thickly set with small hills, the oasis was not perceived until we were quite close upon it.

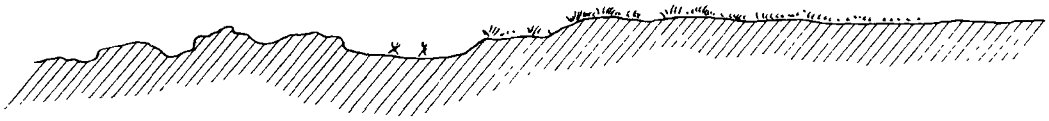


Fig. 144. VERTICAL SECTION FROM S TO N THROUGH THE NEWLY DISCOVERED OASIS.

Under the eastern edge of the oasis there is a distinctly eroded torrent 3 to 4 m. broad and a couple of meters deep. The saliferous water gushed out of the soft earthy face of the right side of the torrent in several springs, one of them one meter above the bottom of the gully. This was at that time filled with a long strip of ice, about a hundred meters long; and from its lower end issued a rivulet, which, still farther down, formed another similar strip of ice. The upper ice-sheet was slushy and soft as snow to the depth of two or three centimeters; though in a sheltered bend it was still firm and bright as glass, and about a foot thick. Vigorous kamisch was growing in the bottom of the gully, and it too helped to preserve the ice, notwithstanding that the temperature of the air was then as high as 15° C. The water, taken at the point where it issued into daylight, had a temp. of 1°.7; its sp. gr. was 1.0232.

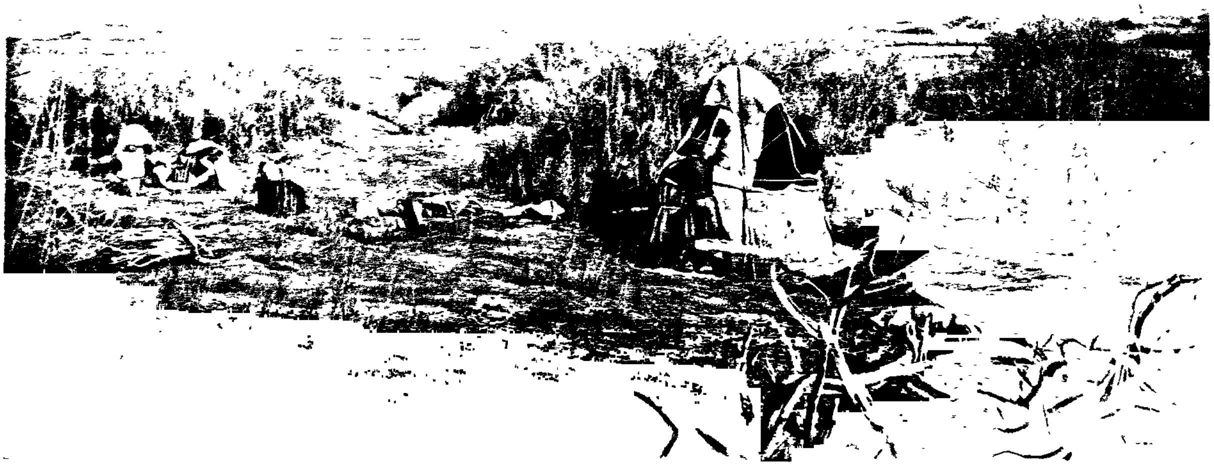
South of the oasis there was a depression with schor soil, and into it the water gathered from the springs. Several tamarisk-mounds likewise pointed to this hollow being a water-reservoir. After that we came to a whole series of greenstone hills and ridges, which, sloping towards the south-east, were cut at right angles by most of the eroded torrents, they too running in this locality towards the south-east. When the hard rock came to an end, the last torrent widened out to a broad passage-way between the big blocks of clay, but soon afterwards became lost in the soft gravelly saj; and this again in its turn speedily gave place to rough, lumpy

Pl. 21

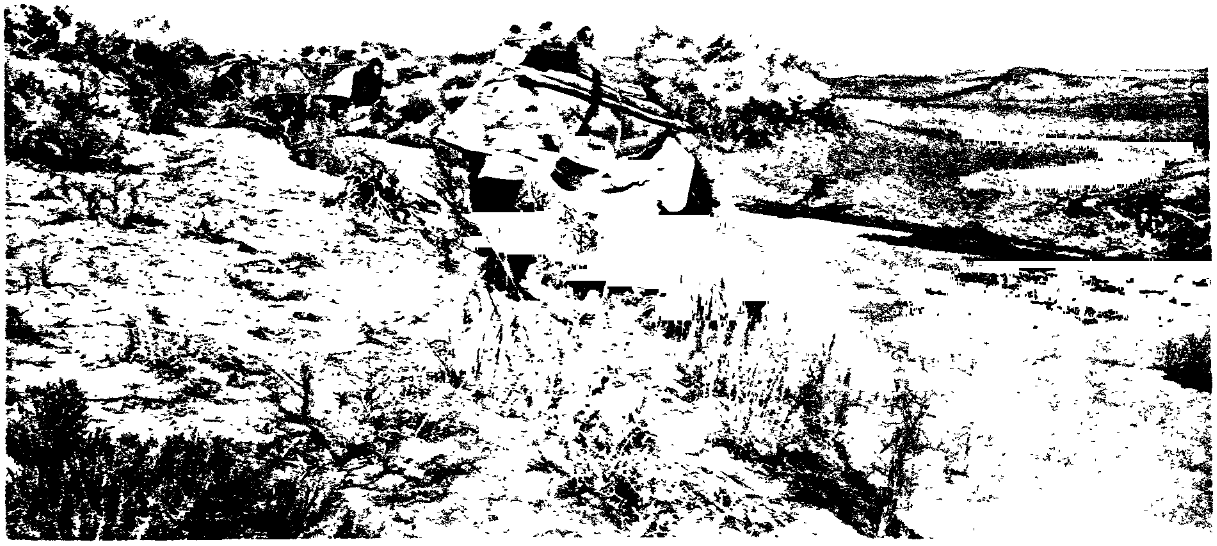
*Ljustr A B Lagrelius & Westphal*

CAMP CLVI AT NEWLY DISCOVERED SPRING SOUTH OF ALTMISCH-BULAK.

Pl. 22.



OASIS AT CAMP CLVI



Ljustr. av B. Lagrelius & Westphal

WATERCOURSE FILLED WITH ICE FROM SAME OASIS

schor. Here too there were bare, steep clay hills, though a good deal smaller and fewer in number than farther east. The first real jardangs on the south of the schor desert were arranged in no decided order; the torrents which traversed them ran in every direction, and were 2 m. deep. But it was not long before they became grouped in the usual parallel lines, forcing us to keep to the south-west. Here also the observation made farther east was repeated again, in that the clay was deposited in three strata.

Once more we came down upon the level desert, and reached the first belt of tamarisks and kamisch-stubble; but as yet there was no living vegetation. We made Camp No. CLVII in the first belt of still standing poplars that we came to. Twice during the day's march we encountered older indications of human presence, first in three stone cairns on the mountain slopes nearest to the spring, and secondly in fragments of earthenware pottery in a couple of places. The mollusc shells occurred at first singly, but soon grew more and more numerous. In the gullies between the jardangs, we frequently observed distinct signs of running water, showing that the rain-water does sometimes get down as far as this.

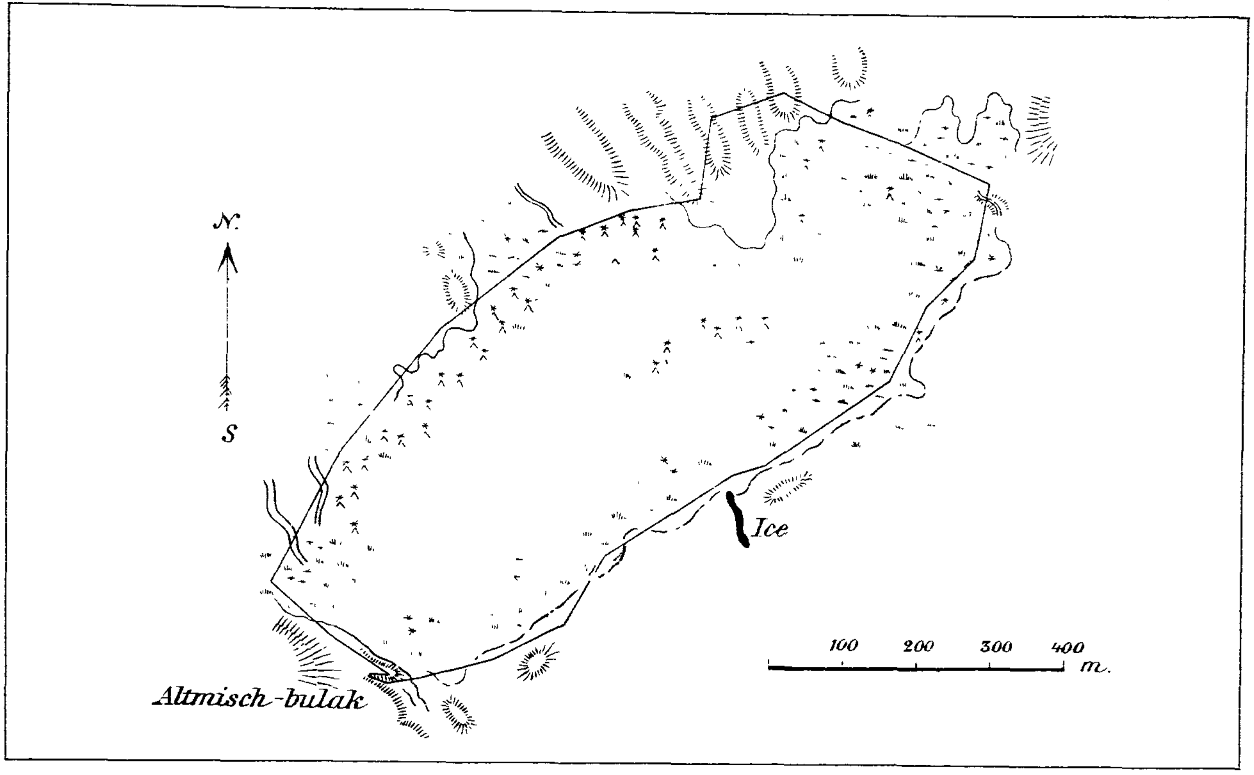
At Camp No. CLIX, which was pitched amongst the ruins of Lôu-lan, I remained from the 4th to the 9th March. As this locality is described in a special chapter lower down, I accordingly proceed at once to deal with my eastern crossing of the Desert of Lop, and the survey I made there.

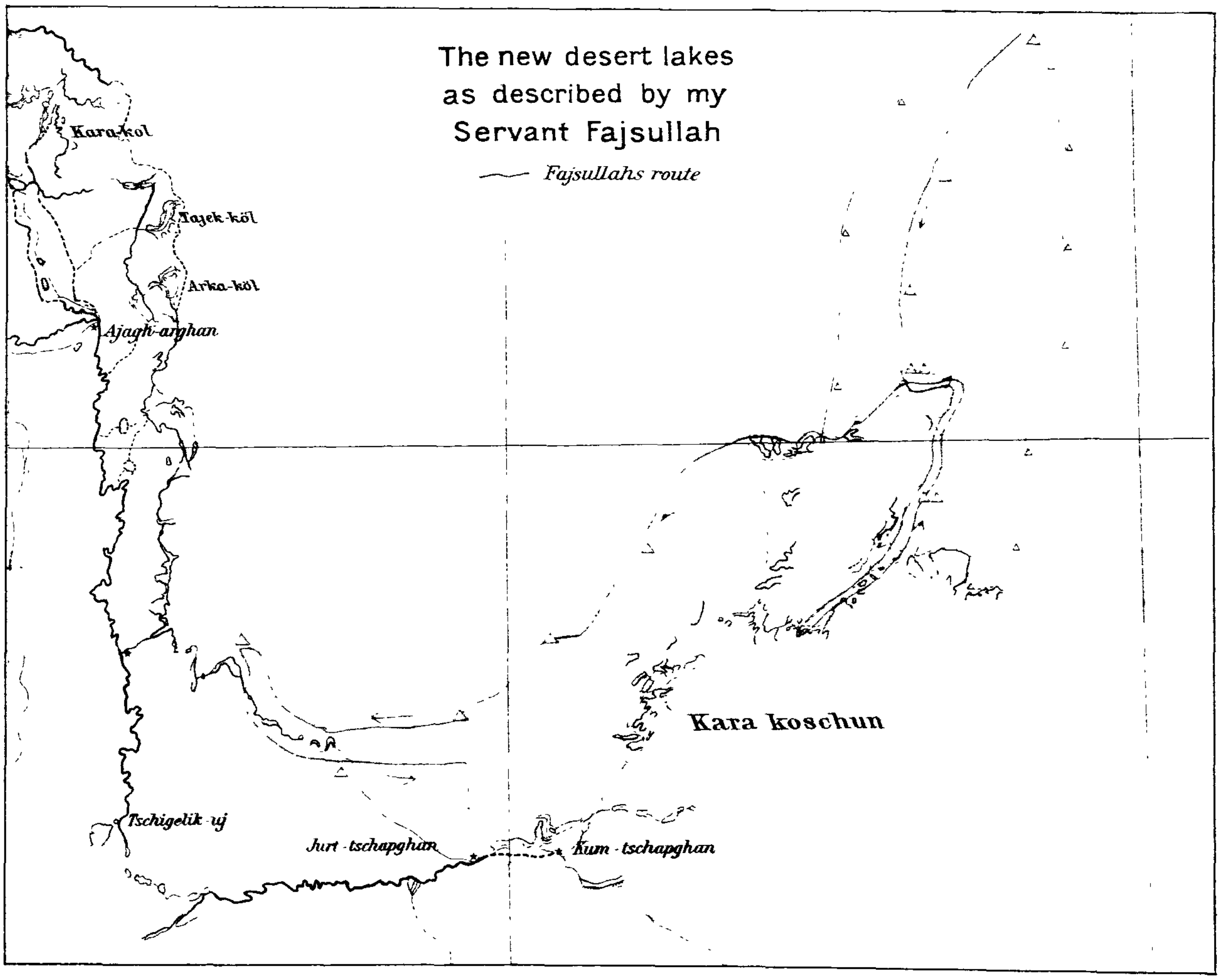
# CHAPTER XVII.

## SURVEYING THE DESERT.

My levelling telescope, obtained from Mr, Berg, mathematical instrument-maker of Stockholm, was adjusted and corrected before I left home. With the view of ascertaining whether it had suffered any injury on its long journey, and if so to what extent, I on 27th February made a traverse round the spring of Altmisch-bulak, the results of which are embodied on the accompanying sketch-map. As the beginning and end of this preliminary survey I selected the little threshold of hard rock on the right side of the torrent that flows down from the spring. The oval-shaped polygonal I measured had a circuit of 2756 m. The readings were + 8.005 and — 8.004 m., so that the error only amounted to + 1 mm., and for the purpose I had in view, the instrument might therefore be regarded as practically free from error. Even supposing that the error + 1 mm. were a constant error, the total for the whole survey across the desert would not amount to more than between 29 and 30 mm.

The levelling-staff was 4 m. long, and graduated to meters, dm., and cm., and it was also easy to take readings down to mm. The distance between the levelling-telescope and the staff could have been read directly from the horizontal lines of the telescope, but I preferred to use always the same distance, and for that end two of my attendants with a 50-meter tape measured off 100 meters, 100 m. from staff to telescope and 100 m. on the other side from telescope to the next staff-position, and so on all the way across the desert. This was not only a saving of time, but it afforded me an opportunity to jot down my observations whilst the men were measuring off the next 100-meter distance. Sometimes the nature of the ground compelled us to take a shorter interval than 100 m.; but in the last part of the traverse, after the surface became perfectly level, I increased the intervals a little. The direction was controlled by the compass. As I had reason to suppose that the Kara-koschun extended towards the north-east, I thought it advisable to aim for the south-east, so as to reach its shore as speedily as possible. Had we steered south-south-west, as we had done the year before, we should have got into very heavy sand, and in a survey sand must under any circumstances be regarded as an additional source of error. Besides, in that direction we should also have struck the





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desert lakes we discovered in 1900, but of whose connection with the Kara-koschun we as yet had no knowledge. What I wanted to ascertain was the general relations of level which obtain in the desert, the difference of elevation between the country around Lôu-lan and the Kara-koschun, and how far the existence of a northern depression admitted of demonstration. I knew there was a southern depression; the water in the Kara-koschun was proof of it. In a word, I wanted to learn whether the contours would warrant the solution of the Lop-nor problem which Baron von Richthofen had offered. His view was, as is well known, that the Kara-koschun cannot be identical with the Lop-nor, but that the basin of the latter must lie to the north of the Kara-koschun. Even without a survey, I had been able to prove that von Richthofen is right, when I discovered that the Kuruk-darja formerly emptied itself into a lake, the existence of which was best proved by the occurrence of millions of mollusc-shells. As far back as 1896 I put forward the suggestion, that the Desert of Lop as a whole must be practically horizontal, that is to say, the differences of elevation within its area could not amount to more than a few meters. Accordingly a survey-line drawn through the desert would settle the point, and put an end to the controversy which was first started by von Richthofen and Prschevalskij, and continued by Kosloff and myself. If the result of the survey was to show a gentle slope southwards from Lôu-lan, the probability would be, that the Kara-koschun formerly extended as far north as Lôu-lan, and thus covered the whole of the Desert of Lop; that the existing Kara-koschun is only a fragment of the historical lake of Lop-nor; and that Prschevalskij, Kosloff, and others are quite justified in calling that lake Lop-nor. On the other hand, if the survey disclosed a depression existing north of the Kara-koschun, it would prove not only the possibility, but also the probability, of the lake having existed formerly in the northern part of the Desert of Lop.

I now proceed to describe the actual survey itself and the results it yielded day by day, as well as the general appearance of the desert in this its eastern part, and then, when I have all the material before me, I will pass on to an analysis of the results of the survey as a whole.

Owing to the advanced season of the year, and for other practical reasons, I was not able to retrace my steps from the Kara-koschun northwards to the point of departure, so as to obtain a second series of readings by which to control the first. It is of course very desirable that that should be done, for without it the work cannot lay claim to be strictly scientific. It would indeed not be impossible to take the levels of the Desert of Lop, but it would be attended with difficulties, which it was not consistent with my plans that I should attempt to overcome. For that purpose two or three corresponding bases would have been necessary, e. g. one at Jaka-jardang-bulak, another at the lowest oasis of Altmisch-bulak, and a third at the Kara-koschun. It would also have demanded a triple supply of provisions and ice, and camels in proportion; and above all it would have been indispensably essential to select a more favourable season than the middle of March. Accordingly the only choice open to me was to make a single line of traverse across the desert, and endeavour as far as possible to eliminate the sources of error. My levelling-telescope and staff might be regarded as being in perfect order, and the accuracy of the readings was enhanced by taking them at constant distances of 100 m. Owing to the amount of dust that filled the atmosphere the changes of temperature were slight. Every observation was made twice, that is to say, after taking a reading and recording it in my note-book, I repeated it again a second time, and thus was able to check the first reading. I gave the strictest instructions to the Cossack who looked after the staff, impressing upon him the necessity of exercising the utmost care, not to let the staff get displaced in even the slightest degree. The bottom of the staff was shod with iron, and rested in a socket in a brassplate, which was screwed into a piece of flat wood for the staff to rest upon, and this we always used on clay soil, as well as among sand and schor. In taking the readings ahead there was no risk of error, since, once the staff was fixed in a vertical position, there it remained until I had taken my reading; but in taking the backward reading the risk was greater, for whilst I was advancing 200 m. farther south to take up a fresh station with the telescope, the staff had to be given a half-turn, so as to bring the graduated face round so that I could see it. It was here, in this turning movement of the staff, that the utmost care was needed. With the view of keeping to a minimum any possible error that might occur, the Cossack was instructed to turn and balance the staff with the points of his fingers only, so as to avoid exercising any pressure upon it. It was in the sand that these precautions were especially called for, but fortunately we very rarely encountered sand.

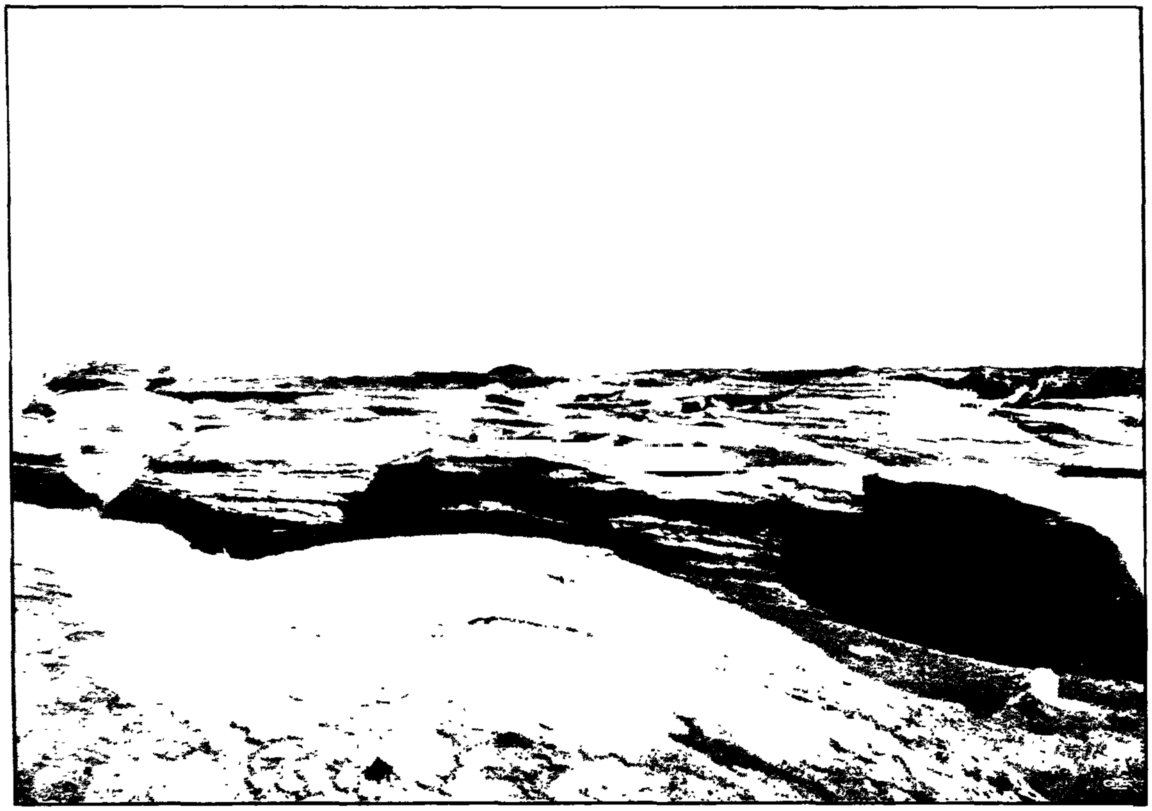


Fig. 145. JARDANGS IN THE NORTHERN PART OF THE DESERT, ALONG THE SURVEYED LINE.

I had four assistants to help me with the rougher work, namely one man for the staff, a second to carry the telescope, and two to measure the intervals with the tape. A fifth man followed behind us with the four camels. It was of course a matter of indifference where we chose to start from, for in every case the altitude of any point along the whole of the line of traverse could be calculated from the water-level of the Kara-koschun. I started therefore at the spot where my tent was pitched at Camp No. CLIX. The difference of elevation, 2.282 m., between my point of departure and the point at which I terminated the survey possesses therefore only an ephemeral value, for neither point is definite. Had I chosen another point in the vicinity of Camp No. CLIX, a point that lay somewhat lower, the difference of elevation would have been still less, and if I had begun at the base of the clay tower the difference of level would have amounted to 10 m. The uncertainty in the case of my terminal point, the water-surface of the Kara-koschun, is not so great, for it depends only upon its rise and fall according as the inflow varies. Nevertheless the indefiniteness with regard to the two terminal points of the survey, and the fact that neither can be regarded as a sure and fixed point, in no sense impairs, for the object I had in view, the value of the survey itself, for each and every point of the intermediate line maintains its relative value with regard to the line as a whole, and the line of traverse itself will always possess a fixed and certain position, no matter how much the water-level of the Kara-koschun may vary. But for a levelling back to my starting-point the water-level of the Kara-koschun would not have been suited just by reason of its oscillation, because its absolute elevation would in all probability have changed during the course of the survey.

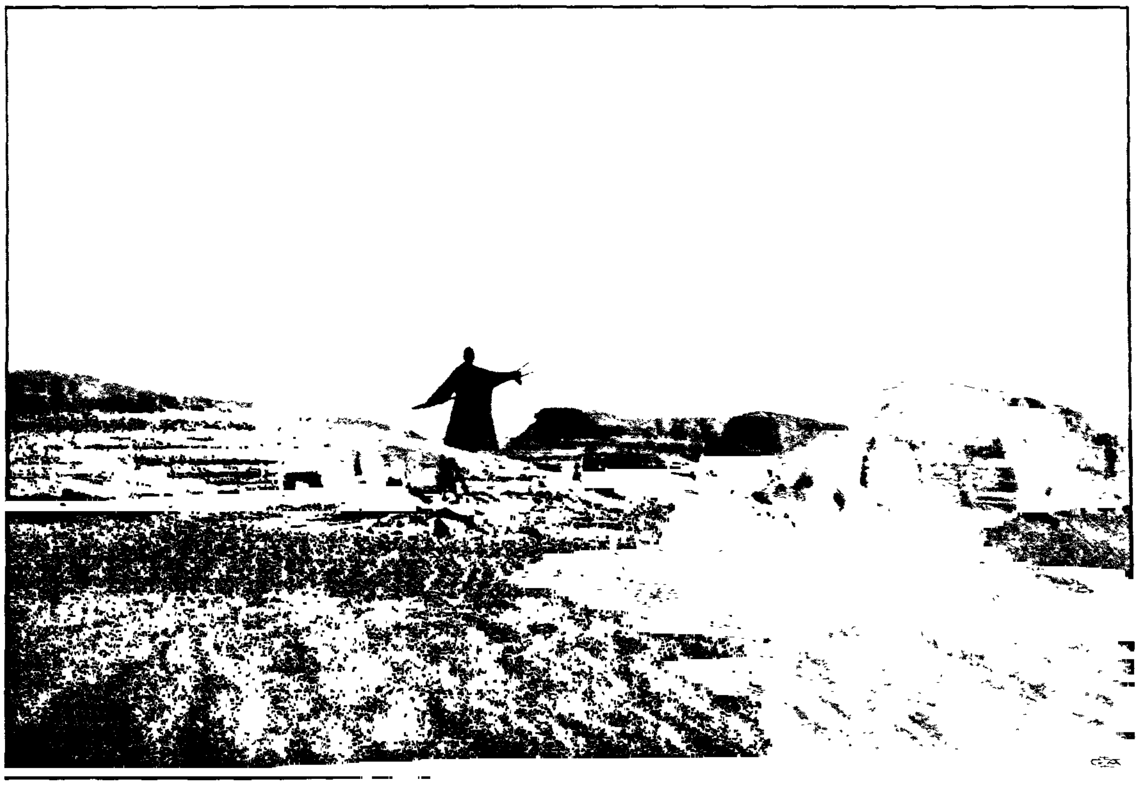


Fig. 146. JARDANGS IN THE CENTRAL PART OF THE DESERT UPON THE LINE OF 1900.

On the 10th March, the first day we were at work, we covered a distance of 9140 m. In that space the desert underwent a great and noticeable change. In the neighbourhood of the ruins of Lôu-lan the surface was relatively broken, the vertical relief being greater there than it was farther south. Nor was this entirely due to the erosive action of the wind; it was due rather to the fact that this strip of country was formerly dry shore with forest and steppe vegetation, whereas the surface farther south was formerly covered by the lake, and consequently was level and free from forest. The houses of Lôu-lan, as well as its toghrak groves, its tamarisks, and its kamisch, all stood upon small elevations of the usual description, that is to say typical jardangs, and in this way were protected against the wind-erosion. Shortly after leaving our starting-point the kötäk diminished in quantity, and sometimes there was none at all to be seen. The tamarisk-mounds were very few and the kamisch-stubble came to an end. The mollusc-shells too, which were so numerous along the old lake-shore, now grew fewer. Everything pointed to the inference, that we were turning our backs upon what was formerly a well planted lake-shore, and were advancing across the bottom of an ancient lake. And this conclusion derives additional confirmation from the presence of the ruins and the traces of the old road, which unquestionably ran along the northern shore of the lake. Owing to the varying consistency of the surface formations, the face of the desert changes a good deal. The accompanying photographs (pl. 24—27) will give a better idea of the jardangs on the northern shore of the lake than any amount of description in words. Even during the first day out they grew smaller and farther apart. Fig. 147 shows an ordinary vertical section through the jardangs in the northern part of the desert; they are about a meter high. It is very curious to see the way in which they have been »undermined» or undercut by the wind. The portion which projects like the edge of a table is composed of harder clay, possessed of a greater power of resistance. The underlying stratum consists of softer material, and into this the wind cuts like a knife. Nor can there exist the slightest doubt but that this insidious undercutting does accelerate the work of destruction. In some cases the »stalk» which supports the table-like top of the jardang is so thin that it evidently cannot be long before it is broken right through. In many places breaches of this description in the clay elevations seem to have taken place quite recently. The blocks of clay thus thrown down lie in the gullies the wind has excavated, and consequently become in an especial manner exposed to its annihilating energy. In this way layer after layer is planed away off the face of the desert, while fresh gullies are excavated and fresh jardangs formed, the general effect being a gradual lowering of the surface as a whole.

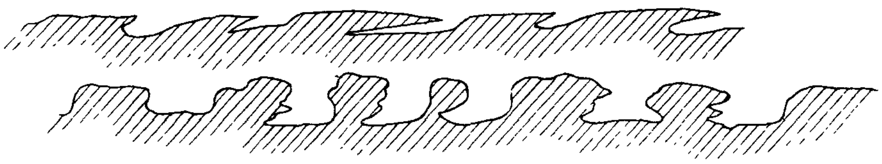
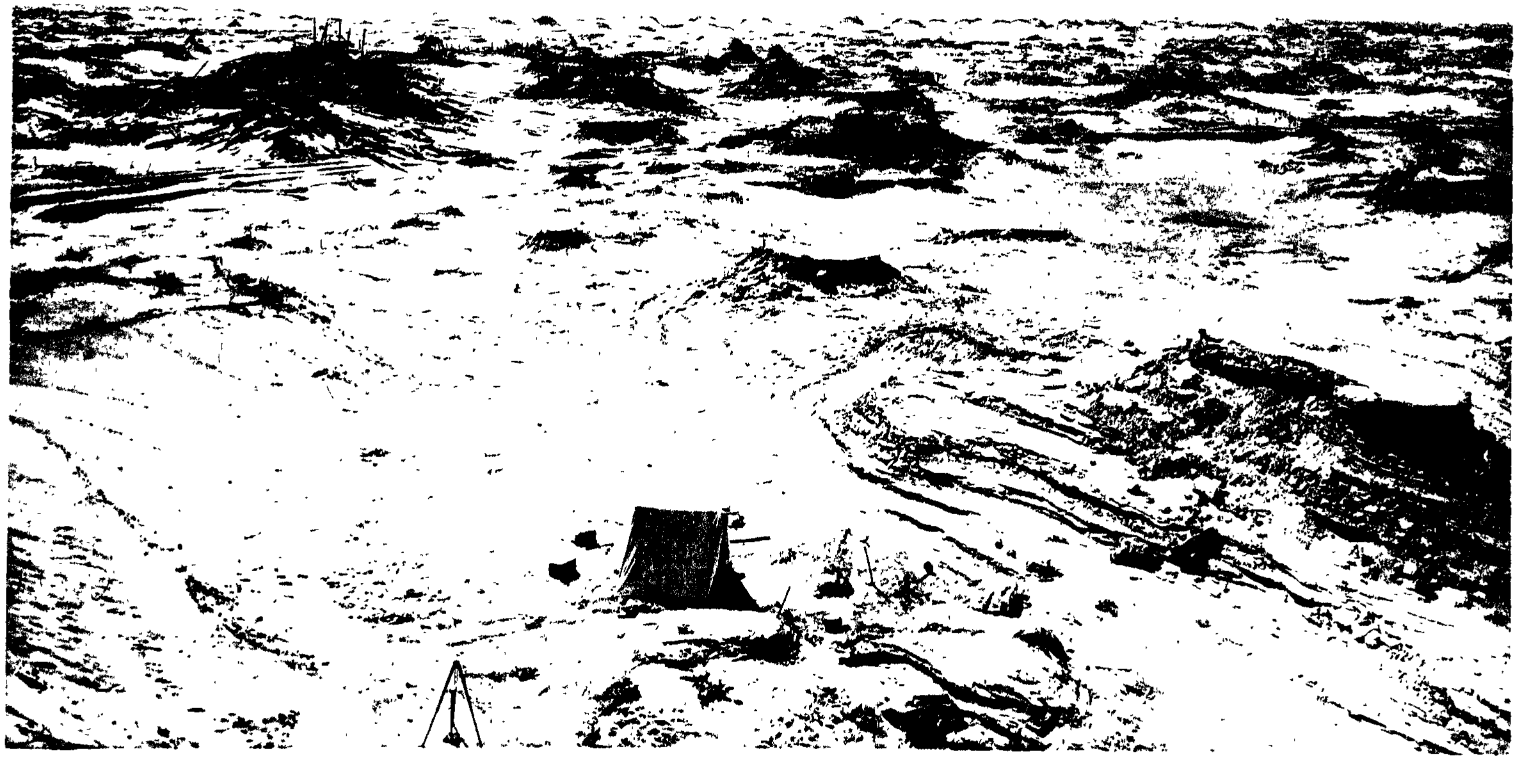


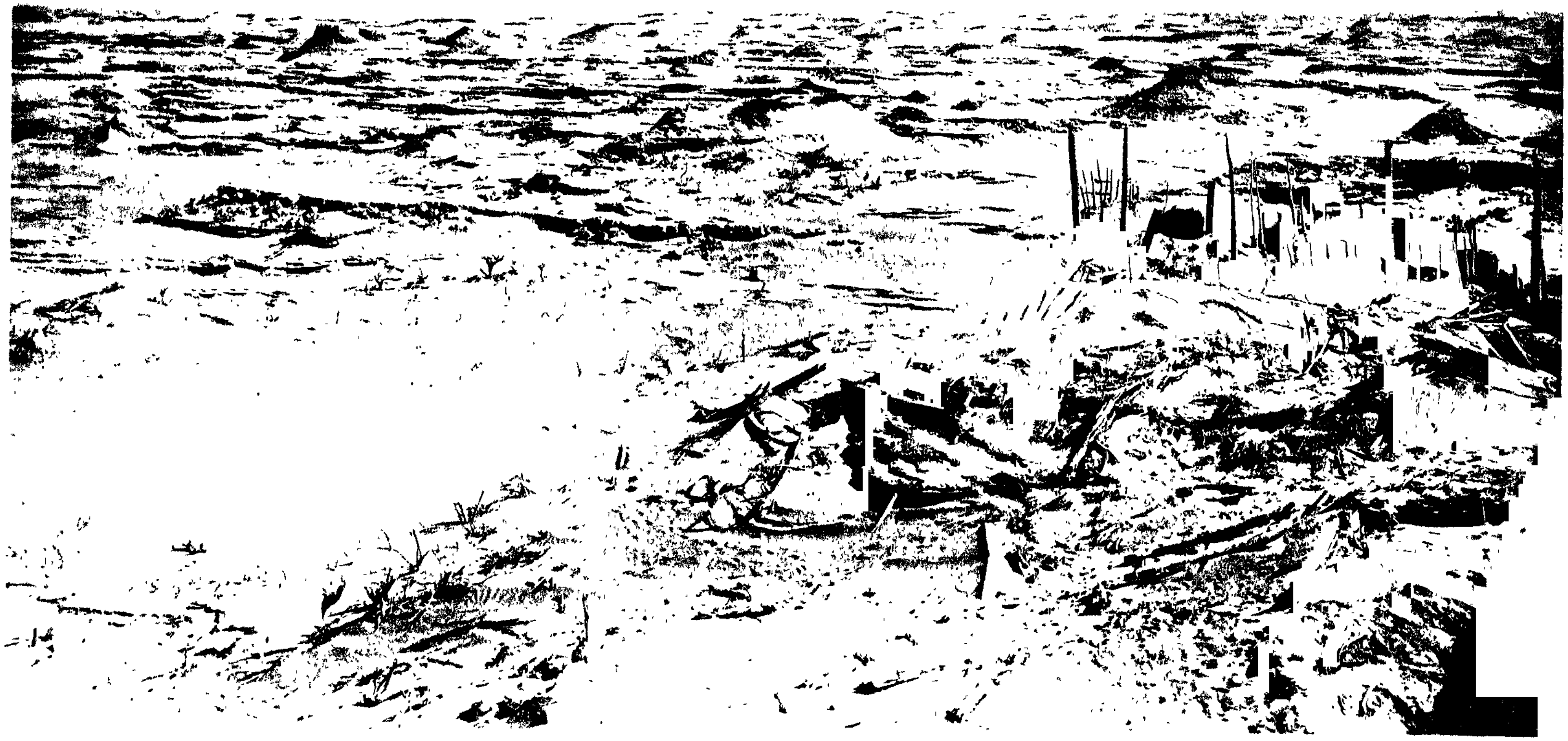
Fig. 147.

Pl. 24.



Ljustr. A. B. Lagrelius & Westphal

VIEW ACROSS RUINS OF LOÚ-LAN, LOOKING S. 60° W. FROM TOP OF TOWER.

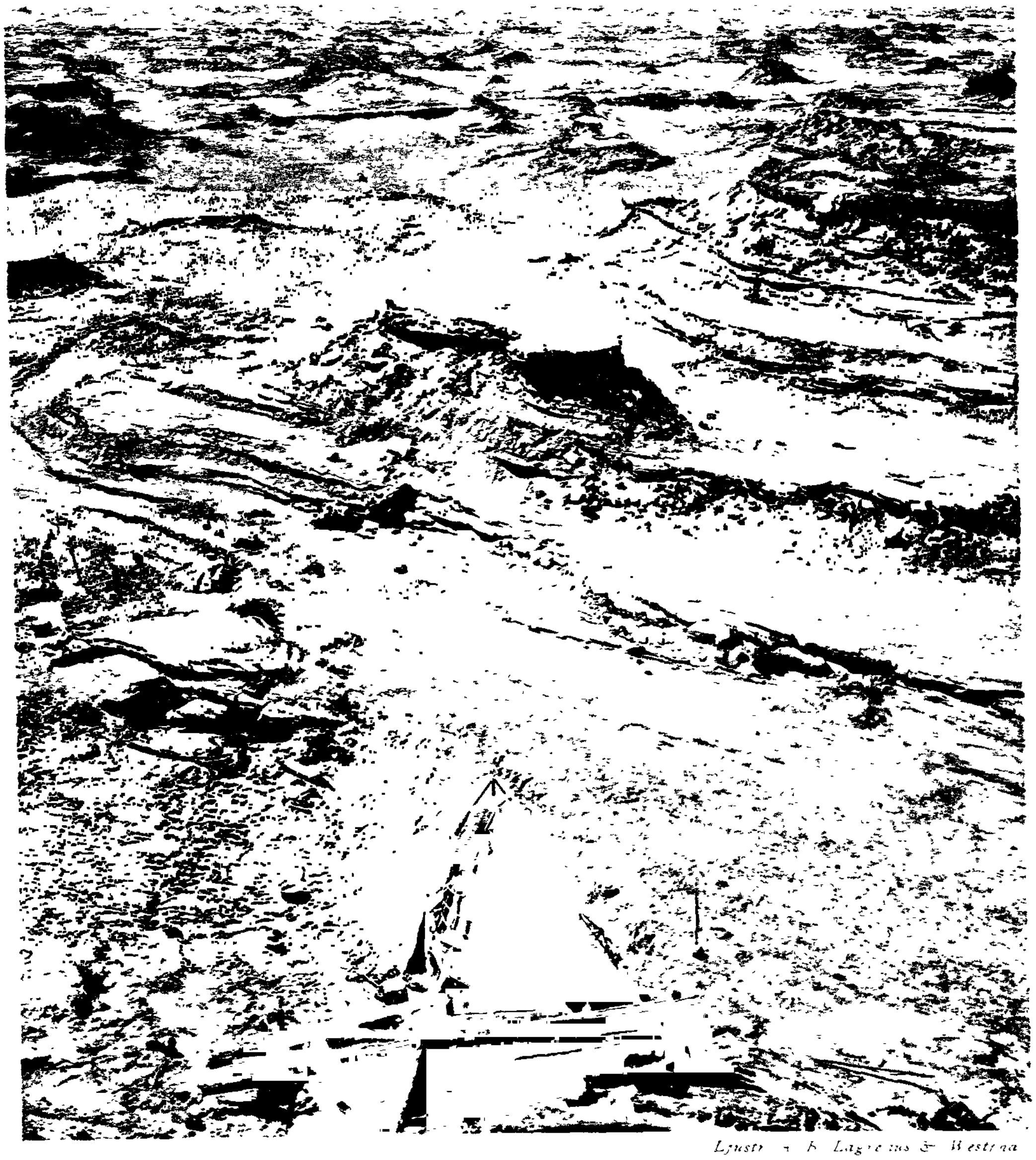


*Ljustr. A. B. Lagrelius & Westphal.*

LOOKING S. 60° E. FROM TOP OF TOWER.

On left and in background numerous jardang ridges; on right the house D

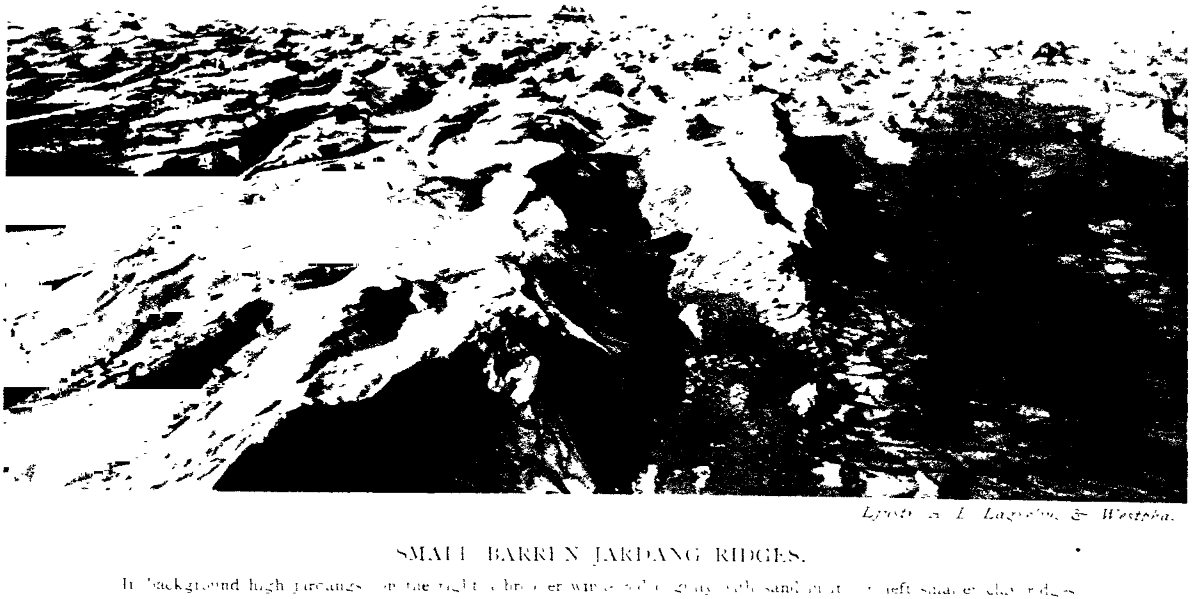
Pl. 26.



*Ljustr. A. B. Lagrelius & Westphal*

LOOKING S. 70 W. FROM TOP OF TOWER.

In middle of picture some typical yardangs, ridges and wind-eroded gullies



Ljustr. A. L. Lagrelius & Westphal.

SMALL BARREN JARDANG RIDGES.

In background high jardangs; on the right a broader wind-eroded gully with sand; on the left smaller clay ridges.
These two illustrations will convey some idea of the difficulties [illegible]

At first I aimed for the south-east, so that we had to cross over these innumerable jardangs at right angles; and this we were able to do travelling on foot, although it was very tiring work. On the other hand this conformation was very favourable for levelling, owing to its raising no hindrance in our path, the instruments being placed on the top of these natural walls. Thus in the northern part of the desert our line of traverse ran along the summits of the jardangs, not in the wind-excavated gullies; indeed it would not have been possible to carry it along these last, because their depth was generally somewhere about 2 m. Farther south, after the jardangs came to an end, and the survey-line ran along the level ground, the traverse naturally was taken at a lower level, in such a way that the deep gullies which occur between the jardangs farther north nowhere appear in the profile of the levelled line. This however is of no consequence. I would only remark, that between the successive stations of the traverse there were hollows and gullies which sometimes lay as much as 3 to 4 m. below the general level. The annexed illustration is therefore merely a rough sketch; as an actual fact the distance between the telescope and the staff was twenty-five times the height of the staff, so that between the two there were generally from 10 to 20 wind-excavated gullies.

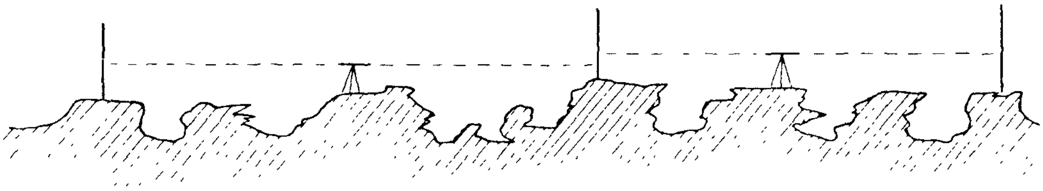


Fig. 148. LEVELLING THE DESERT ON THE TOP OF THE JARDANGS.

In the vicinity of one broad trench (185 m. across) that we crossed over, there were some small detached dunes. The sand was however by this reduced to a minimum, occurring only in thin layers under the shelter of the jardangs. Mounds crowned by dead tamarisks were very few and far between, though they did still crop up at intervals. Along certain stretches there was an utter absence of vegetation; possibly these were the parts of the former lake that were too deep to allow of the kamisch growing in them. Towards the close of the day's march the jardangs ceased entirely in two or three places: the almost perfectly level surface was here strewn with fine dust intermingled with crystals of gypsum.

Upon reaching Camp No. CLX we observed the utmost care in marking the point where we stopped for the day, as indeed we did at each subsequent camp. After marking it distinctly, we protected the spot by inverting a box over it.

The result of the first day's survey was a drop of 0.197 m., which, strictly speaking, is of no significance; for had we placed our last staff on the top of one of the adjacent jardangs, the result would have been a rise of one or two meters: whilst, on the other hand, if we had placed it in the bottom of the channel-like depression on the southern edge of which we were encamped, there would have been an equivalent drop. One fact however was even thus early quite evident, namely the extraordinary flatness of the desert.

Next day, the 11th March, we were forced to lie still where we were owing to a violent storm which had sprung up. On the following day we traversed 11,201 meters in a south-south-east direction, the descent in that distance being 2.466 m. The country remained pretty much the same, except that the jardangs grew still smaller and still fewer. Yet even in this regard there was considerable diversity; sometimes they were as numerous and as close together as at any point farther north, while in other places the ground was perfectly level. Very often we could walk over them with ease. The sand here was incomparably less in quantity than at the corresponding part of our 1900 journey; indeed it was astonishing to find such a great difference within such a short distance. As a rule the sand accumulates under the overhanging eaves of the jardangs, in places where it is less exposed to the wind. Sometimes however a little sand occurs in the eroded gullies, although in thin layers. The sand here was probably brought by the last storm, and was only awaiting the next storm in order to resume its south-westward drift. Dust also accumulates in the relatively sheltered localities, and is excessively soft, like the finest powder. When you tread upon it, your foot sinks through it down to the underlying hard clay soil, and you scarcely notice that it has been any hindrance to your advance. It seldom lies more than one dm. deep, but is always deepest in the best screened situations. In exposed situations not one grain remains.

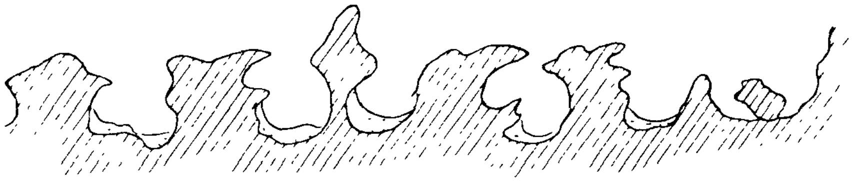


Fig. 149. SOME SAND IN THE GULLIES BETWEEN THE JARDANGS.

The country was inconceivably barren, and in respect of vegetation must in its time have been far less favoured than the region which we crossed on our more westerly route. Only once did we see tamarisks in any number, and they were in part on mounds, in part growing on the level ground; and besides these, only a couple of small toghrak groves, with the trees still upright. But there were no traces of more vigorous or more wide-spread ancient forest, though at every second hundred meters I swept the horizon with the telescope. For long distances together there were no signs of kötäk. When we crumbled small pieces of clay between our fingers, a species of fine down came to light, which may possibly have been the remains of Algæ. In two or three places the kamisch-stubble was very thick and plentiful, and, like that farther west, stood upon small elevations and terraces, which even now resemble islands rising a little above the »curdled» clay waves of the desert ocean.

At intervals the mounds are bare and grey, and without any vestiges of vegetation. In some instances the jardangs attain an altitude of 3 to 4 m. During the day's march we passed a trench 125 m. broad, which could hardly be anything else but a river-bed, either a continuation of the Tarim at some former epoch, or a channel that linked together two or more different lake-basins. As this trench ran from north-west to south-east, it forced us also to travel in the latter direction. It wound backwards and forwards like an ordinary river-bed, and had all the appearance of one; for example, its greatest depths occurred at one of the sharpest bends, where we crossed over it, the vertical distance from the edge of the erosion terrace to the bottom amounting to 8 m. That it was as deep as this I convinced myself by using the levelling-staff. Nor need this great depth occasion any surprise, for in the existing Tarim system there are places where we obtained depths of 12 to 14 m. But it is wonderful to find a river-bed, or at all events a short fragment of a river-bed, in a part of the desert where one would least expect it, where one would in fact only expect to discover traces of former lakes. A couple of toghrak trunks and some pieces of tamarisks were the only traces of ancient vegetation remaining on its banks. Its bottom consisted of soft, powdery material, sometimes dust evenly distributed, sometimes sand in the shape of a couple of dunes which had formed under the lee terraces. As the bed lies at right angles to the prevailing wind, one would expect it to be already filled up, instead of which it is amazingly deep. But at the second place where we crossed it, the depth did not exceed 3 to 4 m. The bottom was plentifully strewn with mollusc-shells. Camp No. CLXI was likewise pitched in a hollow, possibly a continuation of the river-bed I have just been speaking of, though its outline was irregular. It is through some such channel as this that the water possibly once flowed from the northern basin to the southern basin, or *vice versa*. Were the desert lakes described above to be laid dry, several similar beds would come to light, namely those through which the water flows now from the south to the north. In which direction it formerly flowed through the bed we are considering it would be impossible to say. It is also conceivable, that this bed may have formed the immediate continuation of the Tarim at a time when that river discharged into a lake situated in the middle of the desert.

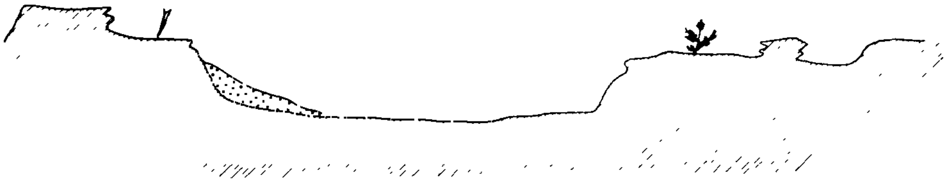


Fig. 150. OLD RIVER-BED IN THE DESERT.

On the 13th March we covered a distance of 13,007 m., in the course of which the surface again rose 2.763 m., so that upon reaching Camp CLXII we were only 0.1 m. higher than at our point of departure. We had therefore now reached the point at which we were about to leave the northern depression of the Lop-nor behind us. Here too the features of the country changed very materially in appearance. The jardangs grew fewer and fewer, and at the same time the expanses of level dust between them grew broader and broader. The jardangs also altered both in form and consistency. In the northern part of the desert they consisted of hard and compact yellow clay, and were in general more energetically modelled. Here however they were built up of a greyish friable clay, the edges of which crumbled away when one trod upon them. They formed bigger, broader, and leveller platforms than farther north, but at the same time they were on the whole lower, seldom being as much as 3 to 4 m. in height. Increasingly greater areas were occupied by schor, in places impregnated with salt, and as hard as bricks, and arranged in thin laminæ. Mollusc-shells were abundant everywhere, sometimes lying scattered amongst the dust, sometimes embedded in the clay; and sometimes they lay so thickly that the ground was powdered white with them. Once or twice we observed, about one km. to the west, tamarisk kötäk; but the course we followed was almost entirely destitute of organic life. We only saw a couple of pieces of wood, possibly drift-wood.

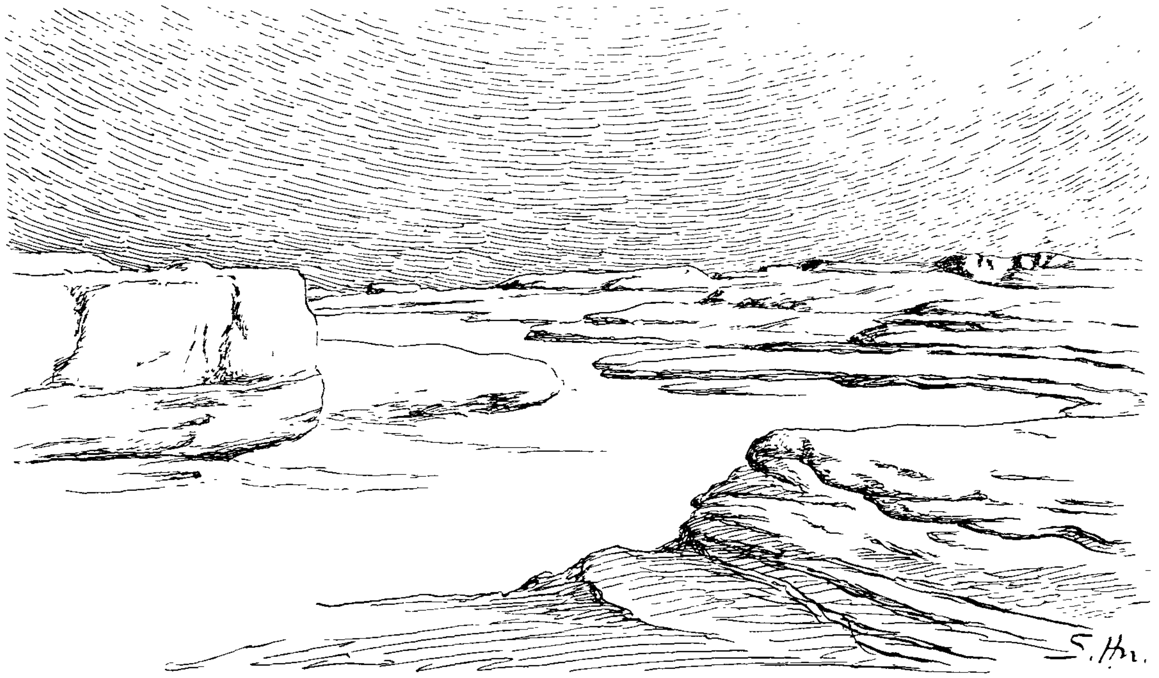


Fig. 151. JARDANGS IN THE DESERT.

The jardangs still continued to grew fewer and farther between, and finally came to end altogether. The country ahead then consisted, right away to the southern horizon, of perfectly level and absolutely barren schor, containing only a very few hollows, barely a meter deep and with rounded terraces at the sides. In one place I fancied I could make out a row of withered tamarisks to the south-east, and to the south-west three sand-dunes, lifting their dolphin backs above the level line of the horizon. Along our route there was an entire absence of sand. Occasionally one would see a foot-deep accumulation in a hollow, but no dunes, not even of a rudimentary character. Yet the three dunes to the west showed, that we were not very far from the beginning of the belt of drift-sand which we crossed on our more westerly route of 1900. At the point where the jardangs came to an end the surface was in some places as if coated with a hard, tough skin of schor; and in this, in the more sheltered spots, we distinctly observed the fine rippling which is produced on a lake-bottom by the shoreward beat of the waves and on the bottom itself in shallow places. The idea that these ripplings were caused by waterwaves was suggested by their occurring only under the lee of the jardangs. Did they owe their origin to the wind, they would have been found in open and exposed situations; but they extended from north-west to south-east, that is at right angles to the direction of the prevailing wind. Wave-ripplings of this character are absent from the usual hard schor; either they have been planed away by the wind or else they disappear spontaneously when the saliferous mud dries.

Here too, as on our more westerly route, the dead vegetation diminished as we advanced from north to south. There was however this difference, that whereas in 1900 vegetation of some sort accompanied us all the way, here in the east since the close of the third day's march the surface had not produced a single blade or a single shoot. Nor did the schor contain the least intimation of organic life. Near our camp on that day we lighted upon a single poplar-trunk, greatly decayed by time; but it had no doubt floated there on the surface of an ancient lake. The schor surface was however peculiarly favourable for our surveying operations. Amongst the jardangs it was hard work, for we had to cross over them all at right angles; here however we were able to continue in a straight line, and the distance between the telescope and staff was increased to 112.5 m. Consequently I had no difficulty whatever in taking my readings; the schor expanse was as level as the surface of the sea, except for slight swellings of no consequence. If, after adjusting the level, I moved the telescope all round the horizon, the distance between the horizon and the middle horizontal hair-line across the lens was always exactly the same. Thanks to the hardness of the ground, there was now less danger than formerly of the staff sinking in, though this risk was, as I have said, entirely counteracted by the brass-plated foot upon which the staff rested.

After we had finished our day's work a storm sprang up in the north-east, and it lasted all night, though fortunately it died away about noon on the 14th March, so that we only lost a few hours. It was very interesting to observe the effects which it produced. We were here, it will be remembered, in the middle of the flat schor desert, where there was no trace of even a rudimentary dune; search failed to detect anywhere even the smallest attempt of the sand to drift together. In fact the only sand we saw was the three dunes I have mentioned, and they evidently belonged to the extreme eastern outposts of the sandy desert which lies in that quarter. Nor were there many other dunes to the south of them; and in the vicinity of Camp No. CLXII there were none even of these outposts within sight. But on the morning of the 14th, after a violent storm of only 27 hours' duration, a little circular dune had formed all round my light Mongolian jurt, which in shape exactly resembled an ordinary tamarisk-mound, that is, it was dome-shaped or beehive-shaped. The little dune around it exhibited therefore the same shape as the circular dunes which grow up round the tamarisk-mounds, and which I have already compared to the Monte Somma that encircles the culminating-point of Mt Vesuvius. This one-night-old dune was of course quite an insignificant thing, not more than 1 dm. high. The greater part of the sand was heaped up, not on the lee side, but to the windward of the tent; inside the tent there was also a considerable quantity of sand, so that all my belongings had to be fished out from underneath it. A more eloquent and more convincing illustration of the way in which the origination of a sandy desert is initiated, and of the way it continues to grow, could not well be wished. To the north-east and east-north-east of us lay the regions of the Kuruk-tagh, from which the sand came; south-west and west was the eastern border of the sandy Desert of Lop; but in the neighbourhood where we then were there were no dunes at all. All the drift-sand which has gone to build up the dunes of the Desert of Lop has however been blown across the schor desert; but by reason of its almost absolute horizontality and the absence of even the smallest impediment, the sand has not been arrested, but has continued on unchecked until it reached a part of the desert in which the jardangs, tamarisk-mounds, and kötäk existing there provided the requisite hindrances for the dunes to accumulate against. Hence it would be rash to say, that the absence of dunes from this part of the desert is due to the relatively recent period at which the ancient lake dried up. If a dune, exceedingly small it is true, but nevertheless perfectly regular in formation, can grow up in a single night, then in the course of hundreds of years dunes of gigantic size could arise, were it not that the winds are so constant, so regular, and so powerful, and that the surface is so level. It is for these reasons too that dunes will be unable to establish themselves here in the future either. This little one-night-old circular dune illustrates also what I have already emphasised with regard to the filling up of the Kara-koschun. When we call to mind, that that shallow expanse of water is 170 to 200 years old, and couple with it the fact that a distinct dune can grow up in a single night, it is clear how immense must in 200 years be the masses of sand which have been transported by the same north-east and east-north-east winds into the Kara-koschun basin, and deposited there. It is amazing, that this depression was not long ago filled up by these stupendous transpositions of material blown into it.

On the 14th March we covered 11,250 m. in a direction S. 1.79° W., and between the two encampments there was a rise of 0.644 m. Thus the desert still continued to be incredibly flat. The results of the survey thus far were that, whereas in the first two days we descended, during the next two we ascended; in other words, we crossed over a depression in the northern part of the desert. Hence the object of the survey was already achieved, and the problem already solved. In comparison with the proof of the existence of this depression, it was of less importance to ascertain the relative altitude of the Kara-koschun with regard to our point of departure. It was at any rate already clear, that we were now on the low threshold or swelling that separates from one another the two depressions of the Desert of Lop.

On the whole the landscape did not really change during this day's stage. We marched all day across the schor desert, and the only difference was that the upbulging parts of the schor surface were somewhat higher than hitherto, and now formed actual ridges or dykes $^1/_2$ to $^3/_4$ m. high, seldom as much as 1 m. These dykes or ramparts possess no fixed or predominant direction, and in this respect differ from the jardangs. Sometimes they run in straight lines, sometimes they wind about, and point to every quarter of the compass. Again, they converge and fuse, and form rings with a hollow in the middle, like miniature volcanic craters. Often too the ground is seamed with dark gaping cracks and holes, or the schor laminæ are piled up in heaps, leaning one against another like drift-ice on a river. These irregularities of surface must therefore be due to other causes than those from which the jardangs have originated. The wind cannot have had anything to do with them; on the contrary, it appears to be powerless to produce any effect upon this hard surface, an almost stone-like cement of sand, dust, lime, and salt, with additional patches of salt embedded in it at intervals. It is of course possible to suppose that this region has been dried up too recently for wind-grooves to have had time to form. But the more likely explanation would appear to be the great resisting power of the schor material. In the clay desert farther north the conditions are not the same. The drift-sand which the wind blows before it acts as an abrasive, without the aid of which the wind would never have excavated such deep gullies as now exist between the jardangs. The relatively soft clay soon yields to the incessant filing. But the schor is incomparably harder than the clay just alluded to, so that the drift-sand is unable to make any perceptible impression upon it.

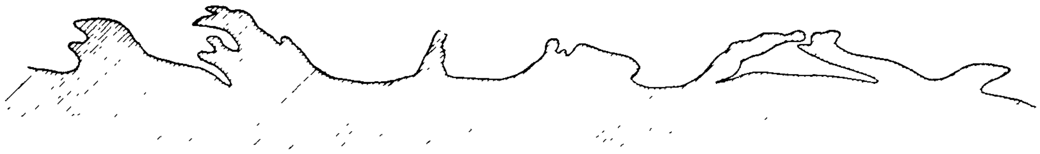


Fig. 152. SURFACE OF THE SCHOR DESERT.

This part of the Desert of Lop resembles, down to the minutest details, the belt of schor which stretches along the southern shore of the Kara-koschun; the only visible difference is, that the swellings and ridges of the Desert of Lop are a little the higher, while in shape and appearance they are exactly like those to the south of the Kara-koschun. In this respect therefore there is still a striking resemblance between the northern and the southern depression of the desert. The northern basin is shallowest towards its southern side; the water there would appear to have been saltish, just as that of the Kara-koschun is now in a similar part of its basin, and in the same direction too the former would appear to have been devoid of vegetation. In both basins alike, as a natural consequence of the bathymetrical relations, the water has disappeared from the south to the north. When I visited the southern side of the Kara-koschun it was characterized by an absence of faunal life; along the stretch of desert which we covered on 14th March we did not see a single fragment of a *Limnæa* shell. It is impossible to say how far the periphery of the former lake of Lop-nor was of the same shape as that of the existing lake of Kara-koschun, because all that I have to depend upon is a *single* surveyed line. But I believe that in this respect the one was like the other, that is the long axis of each extended from south-west to north-east, or from west-south-west to east-north-east. This agrees with the predominant relief of the desert formations, as we have seen, at any rate, in the arrangement of the wind-excavated gullies, the jardangs, the dunes, and the water-courses, and especially in the recently formed desert lakes. But this same parallelism does not exist on the southern shore of the Kara-koschun; its shore runs in a straight line. The circumstances seem to point to the general law, that where the shore consists of clay, the outline of the lake is exceptionally denticulated, with creeks and bays running out towards the north-east, but where it consists of schor the shore-line is straight. If the northern depression were now to be filled with water, its northern shore-line would in all probability resemble in this respect the shore-line of the existing lake, that is, it would exhibit a deeply denticulated outline on the north and north-east, but on the south, i. e. in the existing schor region, a more evenly rounded outline.

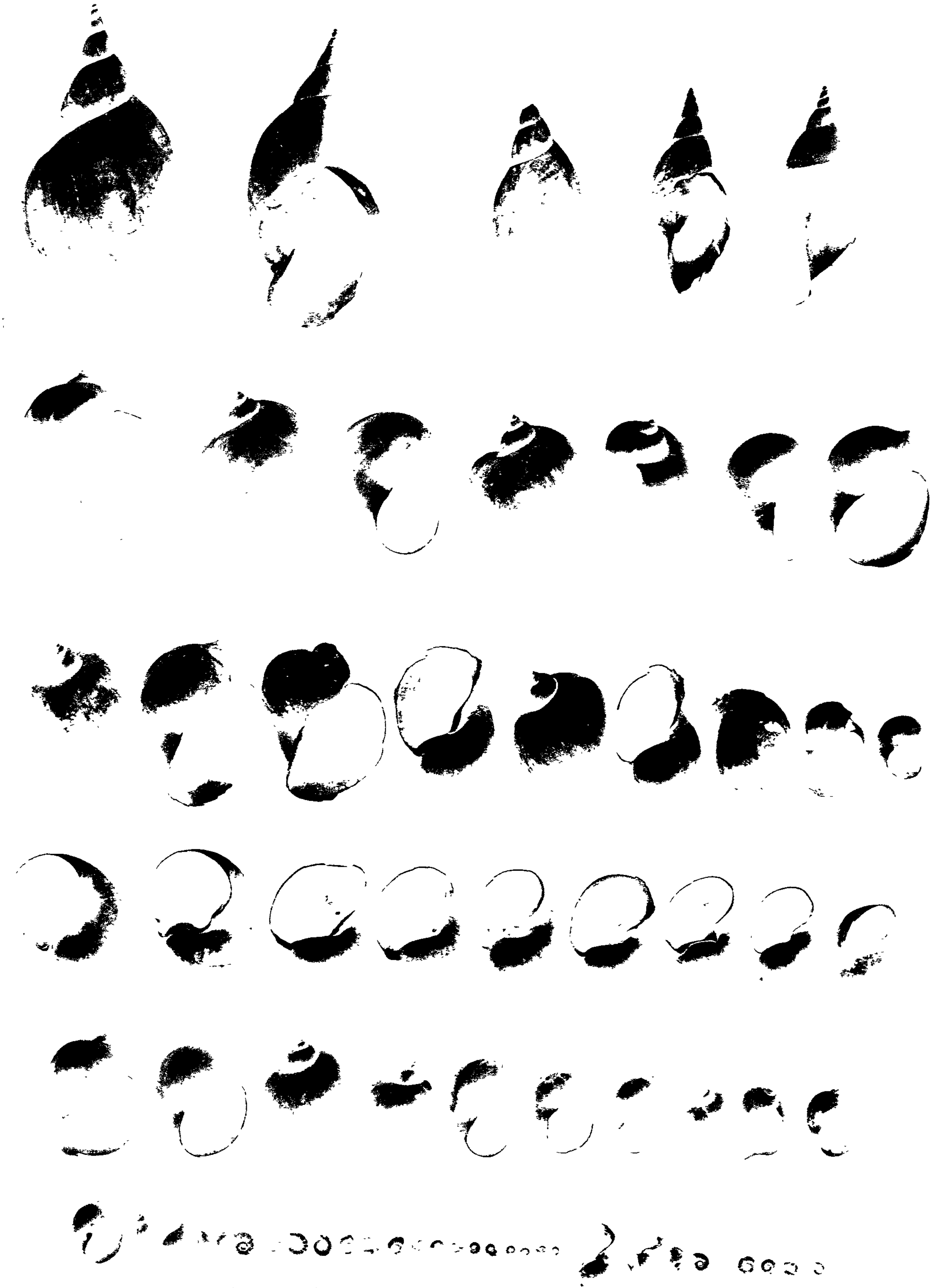
The annexed section of the line of survey shows clearly, that the ground is leveller in the schor desert than in the clay desert, and that the differences of elevation are there extremely unimportant, in fact they are such as only become evident in a survey. To the eye, as indeed to any ordinary instrument, there is of course no perceptible difference at all. This state of things can only have been caused by water. The lake which once existed here was remarkable for its shallowness and uniformity of depth, just as the Sate-köl of the Kara-koschun is now. The sediment was laid down in uniform layers; but after the lake disappeared, and its bed dried up, and after the saliferous bottom mud hardened into schor, certain processes of expansion must have taken place in the thin crust, resulting in the swellings and ridges alluded to. Had those processes been processes of contraction, the result would have been a series of cracks or crevices; but it is precisely these swellings that are the characteristic feature. In some places one may hear the surface slightly crackling, pointing apparently to alterations brought about by changes of temperature.

In consequence of these swellings in the schor desert its horizon-line assumes a serrated and ragged outline. You imagine that what you are looking at is row upon row of withered tamarisks or toghraks, whereas it is nothing more than the upturned edges of the sheets of schor.

On the 15th of March, the weather being fine and the ground favourable, we covered fully 16,239 m., travelling south-south-west, the descent in that distance being 0.304 m.; from this it is to be inferred, that we had crossed the threshold or «watershed» which in that meridian separates the two depressions of the desert the one from the other. The whole of the day's march led across schor of the same appearance as that hitherto described, except that the ridges and crests were rather lower. But there was one thing which we had not had the day before, namely old river-beds, most of them occurring towards the end of the day, and directed towards the N. 64° E. They resembled the arms of an old delta, an embouchure region where the Tarim or some part of it once emptied itself into a lake. The breadth varied from 4 to 20 m., and the depth from 1½ to 2½ m. The bottom was covered with fine dust or a thin coating of sand; and here again there were vast quantities of *Limnæa* shells. In the last bed, beside which we encamped, they were so numerous that they crunched under our feet as we walked about amongst them. It is hardly possible to conceive that these shells were transported thither by either water or wind; they must be actually *in situ*. But elsewhere in the schor desert we found no mollusc-shells.

About half-way we passed some small depressions, which were not river-beds; but, although just as sharply outlined and just as distinctly cut, they were lake-basins,

Pl. 28.



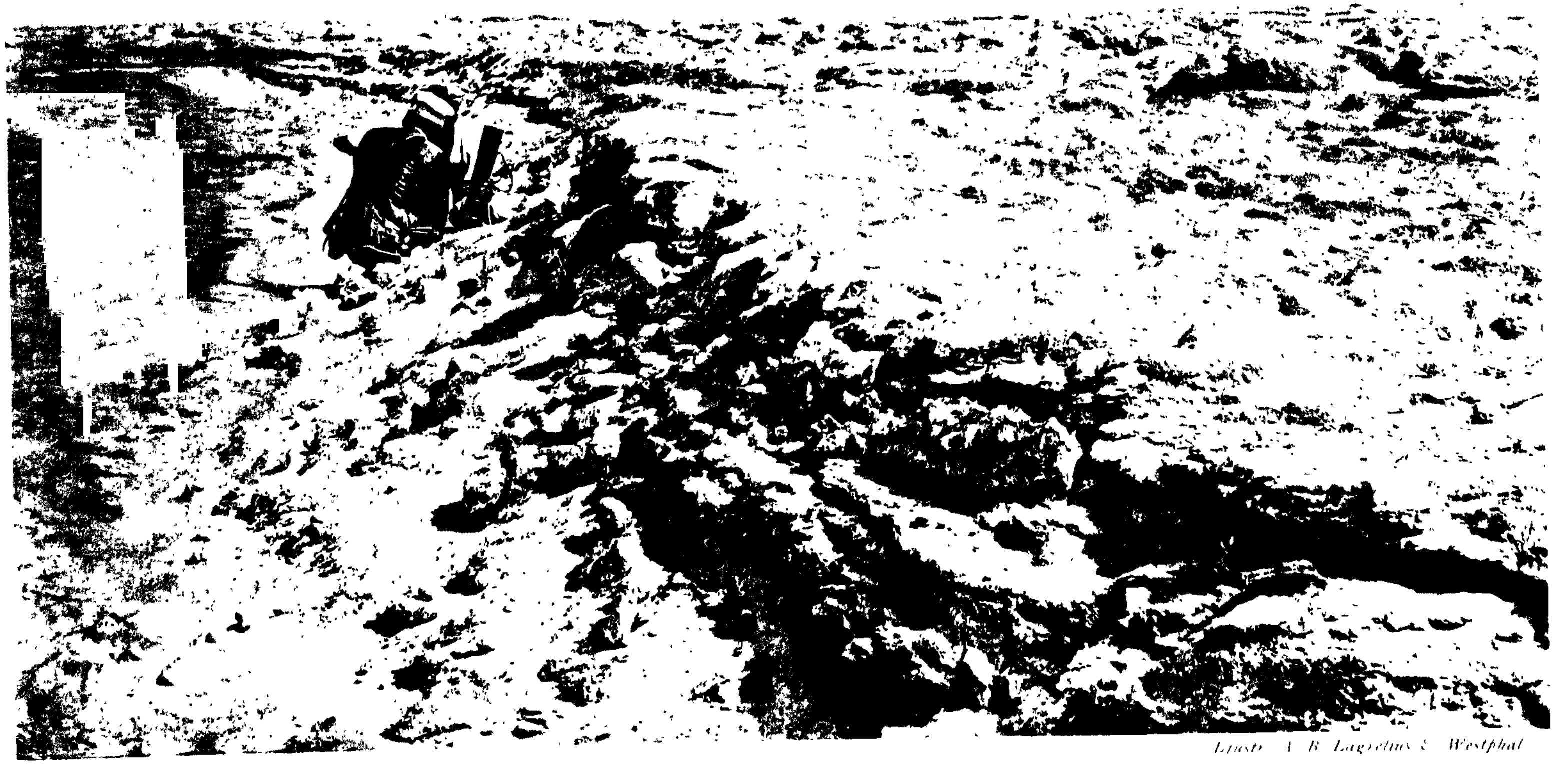
*Ljustr. A. B. Lagrelius & Westphal.*

SPECIMENS OF MOLLUSC SHELLS FROM DESERT OF LOP — *Limnæa stagnalis*, *L. auricularia* (*L. ovata*), AND *Planorbis*.

For an explanation see p. 460, where instead of Pl. XX read Pl. 28.

but somewhat deeper than usual. Some of these pits might just as readily belong to the one class as to the other; it was impossible to tell which. Even in the case of the unmistakable river-beds it was strange how they dwindled away in both directions until they disappeared. Seeing that the parts which we crossed over all lay in a south-west to north-east direction, parallel to the lowest Tarim and the Kara-koschun, and to the general relief of the desert, it is conceivable, that only those parts of their courses are preserved which run parallel to the prevailing wind, while the other parts have been obliterated. A photograph of one of these river-beds is shown on plate 29. In its case there cannot exist any doubt as to the origin of the channel. It is not however always so easy to interpret straightaway the traces which erosion has left behind it on the surface. If, for example, the whole of this region were at one time a lake, it is difficult to account for the presence of the round pit-like hollows we passed during this day's march. Are they simply deeper spots in the larger lake, or are they survivals of other lakes which were formed at some later epoch in the basin of the older lake? Certain things are at any rate clear, namely that throughout long periods the water, river sediment, drift-sand, and dust have been everywhere levelling down this great basin, that the hollows which descend one or two meters below the general level have been formed by water, that the directions and distribution of the flowing water became gradually more undecided in proportion as the basin was filled and levelled up, and that in consequence of this the tendency of both rivers and lakes to shift their positions has been accentuated.

I have already said, that the absence of the wind-gullies in the schor indicate that this type of desert offers more effective resistance to the wind's erosive energy than does the clay desert. I have also assumed, that the southern part of the Lop-nor dried up sooner than the northern, just as is the case at the present time with the Kara-koschun. Thus the southern parts of the floor of the Lop-nor would be exposed to the wind for a longer period than its northern parts, and the effects of the wind in the former would be more distinguishable than in the latter. But in reality the case is exactly the reverse of this, the cause being the induration of the schor formation. However that may be, the appearance of these secondary depressions and watercourses seem to indicate, that even in the schor desert the wind does possess a certain abrasive power, although it is, it is true, incomparably less effective than in the clay desert. In the round pit-like depressions considerable portions of the margins are wanting; either this shows where the lakes shallowed or else they have crumbled away under the attacks of the wind. With regard to the surviving south-west to north-east portions of the watercourses, it is probable that the wind, instead of obliterating them, has deepened them still further. As with the missing parts of the pit-like hollows, so here, we may assume that the absent portions were either especially exposed to the levelling power of the wind or else the channels themselves were very shallow. Anyway it is to the wind that the defective condition of these watercourses must in the main be ascribed. The absence of wind-grooving and of jardangs must not therefore be regarded as proving that the wind is altogether powerless in the schor desert; it is not indeed powerless even in the mountains, with their immeasurably greater hardness. Perhaps too the greater sculpturing power which the wind exhibits in the clay desert is only apparent. I have gone on the supposition, that the wind-eroded gullies and the jardangs are intimately connected with the distribution of vegetation, and that it is the prior presence of trees, bushes, and kamisch which has protected certain parts of the clay desert against the excavating power of the wind, thus leaving it free to concentrate its energy upon the unprotected parts of the surface, or at any rate upon those parts of it in which the roots are more scattered, and consequently possess less binding power. We never found any well-rooted dried up vegetation in these wind-eroded gullies; it was always raised on pedestals, often several meters in height. In the schor desert there exist no traces of vegetation; so that the lake which once existed here must have been as destitute of plant-life as are now the southern parts of the Kara-koschun. From the moment when the lake disappeared down to the present day, its bottom has been perfectly bare and homogeneous, and no part of it has offered greater or less resistance to the wind than any other part. If the wind has here gradually planed away the surface layer, as it has done in the clay desert, we possess no direct confirmation of its activity, at least no other means except the form and appearance of the watercourses to which I have recently alluded; they, whilst pointing to the occurrence of the fact, do not tell us the nature of its progress. If now in the northern parts of the Desert of Lop it is the wind-groovings alone that indicate the lines along which the wind has concentrated its energy, while the jardangs with their remains of plant-life alone remain, then, *a priori* and apart from the varying composition of the ground, the wind's transporting power in those parts of the desert in which vegetation is absent ought to be doubly as powerful. The greatly undercut jardangs are evidence of the intensification of the wind's force when it becomes compressed in the narrow gullies. It formed ages ago the paths in which its great force is concentrated. In the schor desert, on the other hand, its erosive energy is evenly distributed, and it enjoys no opportunity, through working along certain determinate lines only, of leaving distinguishable traces behind it. Were the Kara-koschun to dry up at this moment, and its dry basin, which to the eye would beyond doubt be as perfectly horizontal as the Desert of Lop is, to become exposed to the effects of the wind's erosion, the same result would undoubtedly ensue that we now have in the Desert of Lop — clay desert in the north, schor desert in the south — jardangs in the former, a level expanse in the latter. In consequence of the shape of the lake-basin, the summits of the jardangs would lie at a lower level than the surface of the schor, precisely as we find to be the case in the Desert of Lop. On the other hand, the wind-excavated gullies would be not only less distinct, they would also be less numerous, than in the Lop-nor, for the vegetation in the Kara-koschun is confined to kamisch and sedge; apart from a few bushes, it possesses no arboreal vegetation. On the whole however the result would be like what we see in the Desert of Lop. That is to say, the part of the former lake-basin in which the water was fresh, and organic life, both faunal and floral, was present — the part in which the inflowing river deposited its fine clay-forming mud, would be more accessible to the wind's attacks than the part in which organic life was absent, and its water clear and free from mud, and there accordingly the subsequent dry bed of the lake would be composed of nothing but inorganic matter.



*Ljustr. A. B. Lagrelius & Westphal*

BED OF OLD WATERCOURSE THROUGH MIDDLE OF DESERT OF LOP.

A typical piece of what is called shor country

But other factors are certainly concerned in the relation which exists between the results of wind-erosion and the consistency of the soil, and after only two hurried visits to the region it is difficult to form a clear conception of them. I am indeed the only European who has visited the Lop-nor. I could of course have made inquiries amongst the natives and ascertained whether the winds which were blowing in the spring of 1896, 1900, and 1901, were indeed the prevailing winds, the winds typical of the country; but on the other hand, it would have been quite impossible to ascertain how far one and the same storm possessed the same power, and blew in the same direction, in all parts of the desert alike. The quarters to which the wind-eroded gullies point would seem to indicate that the wind does not possess the uniform direction suggested; but the same storm would appear to produce different effects in different parts of the desert. Lacking as we do the requisite observations, our conclusions must in several respects remain mere guesses. And in any case it must be next to impossible to obtain full certainty with regard to the wind relations in the interior of Asia. Hitherto we have heard nothing about meteorological stations in waterless deserts. The point to which I desire to call especial attention is, that the relative difference of elevation of one or two meters which my survey brought to light may quite well be attributed to wind-erosion.

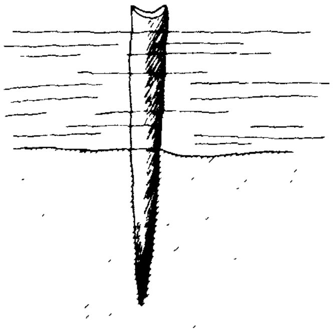


Fig. 153.

A discovery which we made in the vicinity of the above-mentioned round pit-like depressions would appear to indicate, that the level has not been lowered by wind-erosion since the lake dried up. This was a stake of tamarisk wood 35 cm. long, half buried in the ground, and undoubtedly placed there at a time when the locality was under water. The lower end of the stake was sharply pointed and burnt. Three of my attendants, who were Lopliks, thought that it had been used to moor canoes to, when their owners had been out on an exploring expedition, and had been unable to reach dry land before nightfall. At the present day the Lopliks in similar circumstances are accustomed to fasten two or more canoes together in some shallow place, where in case of a storm arising they will not be in too great danger, and so pass the night in them. But it is equally possible that a shore may have run through that spot, and that the stake was situated at its edge. At all events, the condition of the ground showed distinctly that it was moist when the stake was put in; for were such a post to be driven forcibly into the hard schor, the latter would crack and split. But the post was as fast as if it had been cast in the schor, and it required two or three smart side-blows to loosen it. This piece of wood furnished another proof, that this part of the desert was once a lake-bottom, and that the lake was navigated by boats. It would be erroneous to suppose that it was a tent-stake, because the Lopliks when away from home with their canoes sleep under the bare sky.

If now the wind-erosion, or rather corrasion, had been powerful, the stake would not have been buried 18 cm. in the ground, but would have been lying free upon the surface. As to the question, what lake this was, and how far it was connected with the northern or the southern depression — these are matters to which I shall return again later on. I will here only add, that the locality where we found the stake is fully 27 km. from the northern shore of the Kara-koschun, and that the ground slopes southwards the whole way from the former to the latter.

On the terraced banks of the channels near which we pitched Camp No. CLXIV we failed to detect any traces of plant-life; even the kamisch-stubble which is so plentiful in the northern lake-basins was absent. But the presence of the mollusc-shells makes it probable, that vegetation grew there formerly.

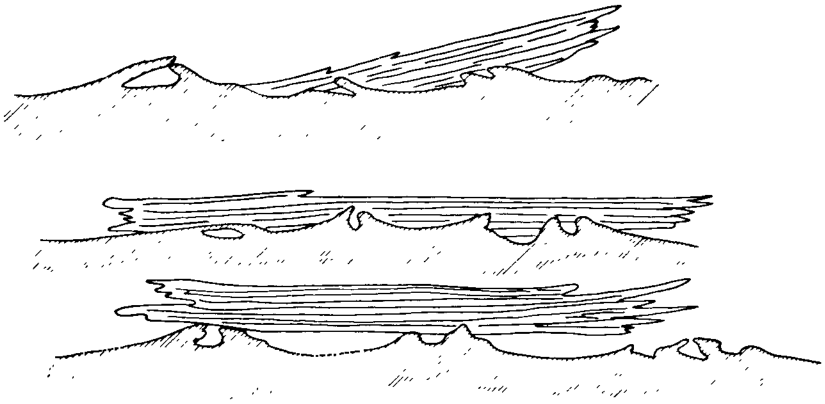


Fig. 154. POPLAR TRUNKS IN THE SCHOR DESERT.

During the latter half of the day's march we passed ten poplar trunks of different dimensions, two or three being of unusual circumference. Most of them were more or less buried in the schor, two only half buried, and two others almost entirely free and lying on the surface. These tree-trunks, which occurred at considerable distances apart, were drift-wood, and had been brought there by the Tarim, and had then floated about on the lake until they grounded. They could not very well have come from the south, at all events during the Kara-koschun period. In the Kara-koschun itself there are no signs of toghrak drift-wood; the poplars which now float down the Tarim ground in the Kara-buran, and east of that lake there are none to be found. The more probable explanation is, that the toghrak-trunks I am speaking of belong to the period when the Tokus-tarim emptied itself into the Utschu-köl, for poplar-forests did grow along that river-system.

On the 16th March we travelled 16,271 meters, towards the S. 2.27° W., the surface descending 2.172 m. from the last preceding camp. Hence we were now distinctly approaching the depression in which the lake of the Kara-koschun is situated. During the first half of the day's journey the desert exhibited the same features as before; but eventually a change took place, and the indications of former shore-lines became more and more distinct. We crossed three quite narrow belts of tamarisks, extending south-west, that is parallel to the present shore of the Kara-koschun. Towards the north-east however and at no great distance they appeared to thin out and come to end, unless they were gaps which we noticed in that direction. The first and most northerly of these tamarisk-belts appeared to accompany

Pl. 30.

*Ljustr. A. B. Lagrelius & Westphal*

MY CARAVAN DURING LEVELLING EXPEDITION. TAKEN IN MIDDLE OF DESERT OF LOP.

an elongated hollow, possibly an old bay or offshoot of the lake. Here we observed some kamisch stubble and numerous *Limnæa* shells. The great majority of the tamarisks stood upon small mounds and were withered, though still retaining their branches. A few of the bushes however appeared to be still struggling to keep alive, in the desperate hope of once more bearing flowers in the spring. In the second belt of tamarisks, which we crossed soon afterwards, the bushes were quite small, and were growing on the level ground without mounds. Some bigger ones were withered, and seemed to belong to a different period. Here too there were köuruk plants, all vigorous and alive. On the sheltered side of every tamarisk or köuruk bush there was a little sand-dune, seldom exceeding a meter in height, and pointing like an arrow-head to the south-west. Accordingly here too the smallest obstacle projecting above the surface causes the sand instantly to accumulate. These three belts of tamarisks, and their faithful associates the sand-dunes, are pretty certainly connected with those parts of the sandy desert which we crossed over in the year 1900. After a good stretch of schor desert we came to the third belt of tamarisks, presenting the same characteristics as the second belt. The barren schor desert was here also entirely free from drift-sand; for this is only detained in and by the zones of vegetation. The ground here was gently undulating, though the only indication of it distinguishable by the eye was the different shading of the band immediately below the horizon. But when we appealed to the evidence of our surveying instruments all doubt was soon put at rest. Sometimes, if we did not pay particular heed to where we placed the staff, the horizontal line of the telescope would intersect it below its 0.000 reading. Now either this undulating surface must have been in existence in the old lake-bottom or else it must have originated after the lake dried up, the varying dilation of different parts of the superficial layer having caused it to buckle up.

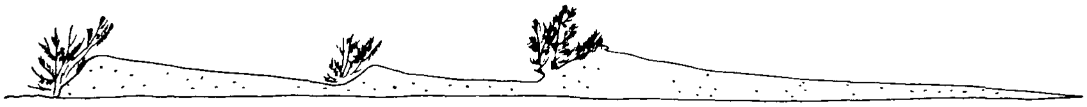


Fig. 155. DUNES FORMED IN THE SHELTER OF TAMARISKS.

I have already described that part of the northern shore of the Kara-koschun where we struck it after finishing our survey. Here too we had a narrow belt of tamarisks and köuruk scrub, together with low sand. The vegetation faithfully followed the shore, and so gave occasion to the sand to accumulate. We need not therefore hesitate a moment in taking it for granted that the three tamarisk belts which I have been speaking of were in a similar way formerly situated on the northern shore of the Kara-koschun, and that, if we were to follow up each of them in turn, we should be able to make a map of the progressive stages of the lake's desiccation, that is of the successive advances of its northern shore towards the south. When we came to the first belt, my attendants had indeed proposed that we should not quit it, but should follow it towards the south-west, for by doing so we should obtain both the grazing that our camels needed and the fuel which we wanted for ourselves. But I assumed that the belt ran parallel to the present lake-shore, and in that case we should not reach the lake for several days. But as it turned out afterwards, had we only advanced a couple of hours or so to the south-west, or even to the north-west, we should have reached the shore of the lake beside which we discovered the huts and the canoe.

South of the last strip of tamarisks the appearance of the schor desert once more essentially changed. The surface became absolutely level, and so soft that at every step we dropped in two or three centimeters, and there were no longer either hard ribbings or crevices. All the same it was perfectly dry; probably the drift-dust had settled upon it whilst it was still moist, and it had not yet hardened. Here there was a thin sprinkling of köuruk bushes, but no tamarisks. Nor were we able to discover any sand, except on the sheltered sides of the plants, and on the inner face of a low clay terrace at Camp No. CLXV.

On the 17th March there only remained 4794 m. to bring us to the actual shore of the Kara-koschun; we travelled S.29°.3 W., and the descent was 0.550 m. Here we increased the interval between the telescope and the staff to 141 m. In this stage we crossed yet two other narrow belts of köuruk, with low sand, running parallel to those already described. Here we noticed the first signs of hares and foxes. The surface exhibited the same features as before, the only difference being that we came upon a low terrace-like swelling of considerable extent, consisting of coarse, hard schor. We caught our first glimpse of the lake from the 17th staff. It had been hidden behind the little rampart of köuruk and sand, and we were so near to it that the 19th staff was placed on the very brink of the water. We encamped (No. CLXVI) a little way south-west of the point where we approached the Kara-koschun; and it was from there that we made the excursion already described round the newly formed desert lakes.

During the last two days we had thus crossed five distinct shore-ramparts composed of plants and sand; and to these must be added a triple belt less distinctly marked, and situated a couple of kilometers north of Camp No. CLXV. Measured from north to south, the distances from the present shore of the Kara-koschun of these six shore elevations respectively are —

| | |
|---|---|
| First shore elevation . . . . . . . . . . . . | 11,760 m. |
| Second » » . . . . . . . . . . . . | 10,750 » |
| Third » » . . . . . . . . . . . . | 8,390 » |
| Fourth » » . . . . . . . . . . . . | 7,040 » |
| Fifth » » . . . . . . . . . . . . | 3,190 » |
| Sixth » » . . . . . . . . . . . . | 2,530 » |

Add to these the present shore-line, the seventh, which on the 17th March was 330 m. from the water-line, a distance which varies of course with the water-level in the lake. The fourth shore elevation is the middle belt of the three that lay immediately beside one another. There cannot exist the slightest doubt that all these shore-lines belong to the basin of the Kara-koschun, and it would need but a very slight rise in the lake for its waters to overflow them again. In the history of the Kara-koschun they serve as mile-stones marking successive stages on its way to destruction. The first elevation proves, that the northern shore of the lake once extended 12 km. farther to the north than it does now, and implies that its area was then at least twice as great as it is now. On the whole the table shows that the lake has shrunk at a pretty regular rate, the only interval that points to a quicker rate than the average is that between the fourth elevation and the fifth. It is of course probable that oscillations took place during the preceding periods, but any traces there may have been of temporary expansions have become obliterated. The hydrographical changes which year after year take place in and around the Kara-koschun form a pretty complicated tangle, and the observations made on one occasion at one place often appear to be contradicted by those made on another occasion at some other place. When I say, for instance, that the lake-basin is being filled up with solid material, which is causing its water-level to rise, then the northern shore ought not to advance south at the same regular rate as the shore elevations indicate; and if the water area of the lake is diminishing to the extent implied, so that there are no less than six shore-lines within a distance of 12 km. from its present northern shore, it is astonishing that the seventh, the nearest and latest shore-line, only two day's journey to the south-west, has been pierced by the masses of water which in the course of only two years have thrust back the shore not 12, but 20, km. towards the north. Yet of this apparent contradiction a satisfactory explanation can be found. Many different factors are co-operating to produce the changes which are taking place. Hence it is obvious, that the changes in question cannot proceed parallel to one another, for in one quarter one factor is predominant and in another quarter another factor. Here mud and sand are being deposited, there corrasion is performing its excavating labour, and it is in this way that the depression of the Desert of Lop is diversified, as we plainly see from the changeable positions and varying distribution of the water. With the object of gaining a general idea of the physical forces that co-operate in the re-shaping of the earth's crust in this part of the world, I will proceed to consider them in combination. Before I do so, however, there are one or two other questions which for a moment or two demand attention.

# THE LOP-NOR PROBLEM

# CHAPTER XVIII.

## THE LOP-NOR PROBLEM. — RICHTHOFEN AND PRSCHEVALSKIJ.

In the preceding chapter I have confined myself to giving some idea of the manner in which, and of the practical conditions under which, my survey of the Desert of Lop was carried out, reserving for a subsequent chapter the full analysis of the results obtained. The two lines along which I crossed the Desert start from the ruins of Lôu-lan, and proceed south, but in such a manner that the western line forms a gentle curve to the west and the eastern line a similar curve to the east, so that after at first diverging, later on they converge again, the maximum distance between them in the interval amounting to 29 km. And yet, although the distance between the two lines is thus everywhere short, the desert nevertheless exhibits very great differences along the two routes, — except as regards the one feature of level. Everywhere along the western route we had the clay desert, traversed by wind-eroded gullies and jardangs, with a north-east and south-west direction, all the way until we reached the northern margins of the newly-formed desert lakes. The schor formation was only visible a long way off to the south, and even then was of small extent. Along the eastern route however the clay was confined to the northern half of the desert, while the southern half consisted of nothing but schor. On the western route the vegetation, or more accurately the remains of the toghrak forests, tamarisk steppes, and kamisch-fields were rather plentiful, although they decreased as we advanced south. On the eastern route these same species of plant-life thinned out before we had gone ten kilometers, and soon afterwards came altogether to an end; and the broad schor desert was as destitute of plant-life as the belt of schor which forms the southern border of the Kara-koschun. On the former route we entered in amongst the sand-dunes the very first day out from Lôu-lan, and the dunes continued to increase in size as we advanced, nor did they begin to decrease until we came into the immediate vicinity of the Kara-koschun. On the east the sand was absent, with the exception of trifling quantities which had gathered under the shelter of the jardangs and the tamarisk-mounds in the south. But though we are warranted in concluding, from what we know otherwise about the western parts of the Desert of Lop, that the sand increases in quantity from east to west, this does not in any way warrant us in drawing the further inference, that the vegetation increases in a similar way. All we know with certainty is, that this abundant vegetation, far more vigorous than that which is found at the present day beside the Kara-koschun, was necessarily associated with water. For instance, the banks of the Kuruk-darja were clothed with forests and steppes, and there was a luxuriant vegetation round the shores of Lop-nor. It is also to be assumed, that the islands and promontories in the lake were likewise forest-clad, at least I infer so from the scattered patches of forest which we saw in different parts of the desert, and which the close conjunction of vast quantities of mollusc-shells suggested had formerly belonged to the lake. When the Tarim flowed due east through the bed of the Kuruk-darja, and emptied itself into the Lop-nor, its banks were all the way adorned with forests, as at the present time, and they formed similar narrow belts. And as the distribution of water is the essential condition of the distribution of plant-life, the forests spread themselves also along the shores of the lake. But when the river burst out of that course, and turned to the south-east and south, the Kuruk-darja and Lop-nor dried up, and the forests died out. In time however new forests grew up along the new course, though as yet they have not advanced lower down than to Tschigelik-uj. We may be quite certain, that so long as the Kuruk-darja and Lop-nor were under water, they were bordered on the south by the same barren and desolate desert regions as at the present time. One has only to travel south from any point on the Tarim, say for example towards the Kerija-darja, to ascertain how narrow the belt of forest is. Precisely the same thing held good in the case of the Kuruk-darja. The sand accumulated there in small quantities only, its passage being hindered by the river, so that dunes were only able to form at a considerable distance from it. Apart from this, the country was bare desert. I suspect therefore that, if from our western route we had travelled west across the desert, we should have found that the forest thinned, and finally ceased, before we came into contact with the Kontsche-darja and its lakes.

Apart from its forests, the Lop-nor bore a great resemblance to the Kara-koschun. In both we have the mouth of the Tarim in the west and a string of lakes stretching out towards the east-north-east. In the Kara-koschun the fresh river-water ensures in the west a more plentiful organic life, both faunal and floral; in the east the water grows salter and salter, and consequently the vegetation thins out. The causes of the rapid decrease of vegetation from west to east in the northern lake-basin were clearly in every respect the same. The forest at all events continued east from Lôu-lan, but those parts of the lake which contained salt water were also destitute of plant-life. Our western route across the desert probably traversed the tracts of forest which grew on the western shore of Lop-nor.

In my earlier books I have dealt more or less exhaustively with the Lop-nor problem and its history;* but, now that the problem has been definitively solved, I conceive I ought to touch again upon the main points of the controversy which have invested this problem with such a fascinating interest, and I feel under all the greater obligation to do this because Kosloff, in the book that he has recently published, has devoted a very great deal of attention to this question, claiming to have settled it in a sense favourable to Prschevalskij. Strictly speaking, this controversy, which has now continued for 25 years, may almost be disregarded, seeing that all the arguments, geological as well as historical, no matter whether they tell for the one party or for the other, are alike superfluous; for the facts, both the geological facts and the historical facts, speak their own plain and irrefutable language. But it is just because we possess these facts that it will be interesting to glance back over the different phases of the discussion, for the facts themselves are well calculated to bring out the real value attaching to the several arguments.

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* See my Swedish translation of Prschevalskij's explorations in *Central-Asia — General Prschevalskij's Forskningsresor i Central-Asien* (Stockholm, 1891), Pref. p. 31. Also *Through Asia; Peterm. Mitteil.*, Ergänzhft 131; and *Central Asia and Tibet.*

An account of Prschevalskij's second journey in 1876—77 will be found in Delmar Morgan's translation;* and the same work contains the controversy which arose between von Richthofen and Prschevalskij. Here I will cite a couple of passages from the paper** by von Richthofen, using Morgan's translation. Knowing, as we now do, that von Richthofen was right, it is especially interesting to recall the arguments upon which he relied. His proof is remarkable for its acute discernment, and his paper deserves to be regarded as a classic document in the history of the exploration of Central Asia. I may add, that it was this paper which led to my making both my journeys to the Lop-nor region. Richthofen says:

»It is remarkable, that Prejevalsky found the last reservoir of the Tarim much farther south than the maps and Chinese information placed it, and that the water was fresh instead of salt. — — — The statement about the second basin (Kara-koschun), which answers to the true Lob-nor, and must be the last evaporating reservoir of the Tarim, is most surprising. The region through which the Tarim flows is highly charged with salt, springs of sweet water are rare, and only appear on the borders of the mountains. — — — The water of the Tarim must therefore contain a larger proportion of salt than any other of the larger rivers of the world; and the unusual amount of evaporation, continued through a great many centuries, must have produced a very large deposit of steppe salts of all kinds. The Chinese from ancient times have called Lob-nor *the* salt lake, in contradistinction to the many other salt lakes of smaller size. Contrary to theoretical deductions and historical records, we now learn from the first European explorer who has visited the lake, that its water is sweet. Let us endeavour to suggest some explanations.

In winter, when the evaporation is only slight, the river coursing rapidly down to the lake might be expected to diffuse sweet water over the strongly condensed alkali. But, on the other hand, the insignificant depth of the lake would scarcely allow of a dispersion of the salt. A second explanation can be found in the supposition, that the reservoir of the waters of the Tarim has undergone changes as to position. Just as rivers in China periodically change their courses, the Tarim may at different times have filled parts of the saline, clay steppe with its overflow, and this becomes all the more probable on reading the interesting description which Prejevalsky gives of recent occurrences in the river-bed of the Tarim. Particularly worthy of attention is the upraising of the river-bed, like that of the Po and Hoang-ho, above the surrounding plain; allowing the natives to draw off the water for fishing purposes, and assisting the river to change its course by bursting through its embankments at flood times. In this way the Tarim may have left its easterly channel, as hitherto marked on our maps, and the present river flowing to the south-east, with the two lake-basins at its end, perhaps from the neighbourhood of Akhtarma, may be of comparatively recent origin. In such case, the earlier lake-bed had a more northerly situation than at present, and became dried up in course of time.

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* *From Kulja, across the Tian-shan to Lob-nor.* London. 1879; and see also *Peterm. Mitteil.*, Erganzhft No. 53, *Przewalsky's Reise an den Lob-nor und Altyn-tag. 1876—77.*

** *Bemerkungen zu den Ergebnissen von Oberstlieutnant von Prjewalski's Reise nach dem Lop-nor und Altyn-tagh*, in *Verhandl. der Gesellschaft f. Erdkunde* (1878), v. pp. 121 ff., and *Peterm. Mitteil.* (1878), XXIV. pp. 313 ff.

A third and likelier explanation is that, besides the two water-basins seen by Prejevalsky, there remains a third, communicating with the Tarim by an arm. — — — The map (Chinese) also shows* farther to the south-east, and wholly unconnected with the Tarim, another lake called Khas-omo, the centre of which is about 3° east and 1 3/4° south of Korla, not far from where Prejevalsky places Kara-koshun. The question suggests itself, if this Khas-lake does not answer to the black Koshun of Prejevalsky.

This would involve the following, *that the Tarim formerly had only one easterly course to the true great Lob-nor, but later, at the place where it is now joined by the Ugen-darja, it threw off a branch to the S. E., which became the main river; and that this branch discharged into the once isolated Khas-lake, enlarged it and made it the chief reservoir.*

Many arguments may be adduced in support of this presumption besides those already mentioned.

(*a*) The Chinese map represents plains south of Lob-nor, but mountains south of the Khas-lake, and these with reference to the positions of Prejevalsky's lake and Korla occupy the same place that the Altyn-tagh mountains do.

(*b*) South of Khas-lake the main road to the east leads in the direction of Sha-chau, and from it another branches off southward to Tibet, just as on Prejevalsky's map both roads are placed to the south of Kara-koshun.

(*c*) Prejevalsky found that the name of Lob-nor was not applied to either of his lakes, although, from the inquiries of Shaw, Forsyth, and others, it is well known far and wide. But he met with it, evidently without learning its exact meaning, at that part of the Tarim to the east of which the true Lob-nor must lie.

(*d*) Concurrent historical notices on the former trade-routes from China to the west point with certainty to the conclusion, that the region of the true Lob-nor was undisturbed by them, and that they crossed much farther to the south and west of Khas-omo, so that there, and not at Lob, lie the kingdoms of Leu-lan**, Shen-shen, etc., which are named in history as situated near »the salt-lake».

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* That is, in addition to the lake of Lop-nor proper.

** Himly writes this name Lôu-lan.

(*e*) A last and weighty argument is furnished by the only hydrographical measurements taken by Prejevalsky of the rivers observed by him. — — — — — It appears, then, that the united river only brings down a part (probably less than half) of the aggregate volume of water contained in all its branches. — — — — — Now Prejevalsky's route lay between two separate arms of the river; it is therefore possible that the eastern arm discharges part of its water by a channel not seen by him, flowing eastwards to an impassable salt desert, to which the name Lob-nor heard by him, but so mysteriously passed over, may refer.

If it may be assumed as a certainty, that a sweet-water lake, which lies in a steppe of saline loam, and does not serve as a passage for a river like Kara-buran, but allows the water it receives to evaporate, must be of recent origin, our argument with reference to Prejevalsky's Kara-koshun will be confirmed.

We must picture to ourselves the Khas-lake as in former times a small salt-water basin, fed by tributaries from the Altyn-tagh and by the Cherchen-darja and the considerable extension of its area by the irruption of the Tarim, at a comparatively recent period owing to a deflection from its earlier and only eastern course. — — — — Highly as we must value that which Prschevalskij has accomplished for the exploration of Lob-nor, we cannot yet consider the problem for which he has endured such hardships as finally solved.»

Thus far von Richthofen. I have omitted one or two passages of minor importance. This was answered the same year by Preschvalskij, and his reply is contained in Morgan's book. The following passage from it may be quoted here: — — — »In order to reconcile the discrepancies between the Chinese statements and the results of my investigations, Baron Richthofen supposes that the Lower Tarim in comparatively recent times altered its course; a small channel, probably, as the Baron thinks, unexplored by me, continues to follow the former direction to the east towards the true Lob-nor, whilst the chief mass of water, diverted to the south-east, entered Lake Khas-omo, and here formed with its overflow the lakes which I discovered.

It is impossible to deny that such a phenomenon may have occurred. A river with such a rapid stream as the Tarim, flowing in a loose alluvial soil, might easily have changed its course. My opinion, however, is that no such important change has occurred within comparatively recent times, but that the contradictory statements of Chinese maps and descriptions of the Lower Tarim and Lob-nor may be readily accounted for *by the misleading and inaccurate information which the Chinese themselves possessed of these localities.* — — — — — It is unnecessary to repeat the statements contained in my report regarding the hydrography of the Lower Tarim, and I will only add, that the chief cause of the diminution of the volume of its stream, as it flows farther to the south-east, is the diversion of its water into artificial lakes and marshes occupying vast tracts along its lower course, and these, owing to strong evaporation continuing the greater part of the year, absorb an immense quantity of moisture, subtracted from the principal river.

Regarding the possibility of there being another channel by which, as Baron Richthofen supposes, the Tarim carries part of its water to the east, and there forms the true Lob-nor — such a supposition is not supported by the facts hitherto obtained. To say nothing of the circumstance, that the inhabitants would surely have known of such a channel and so large a lake, and would sooner or later have told me about them, we ourselves followed the bank of the Tarim, and could not detect any, not even the smallest, rivulet crossing our road. — — — —

Now with reference to the lakes at the mouth of the chief river, of which there are two: Kara-buran and Kara-kurchin or Chon-kul; both are shallow and contain fresh water. — As regards the former the presence of sweet water can be explained by the fact that the Tarim only flows through it, and its water is therefore constantly renewed.

As to the other enclosed lake-basin, it appears at first sight inexplicable why its water should be sweet. But the facts collected by me on the spot explain the apparent anomaly. The fact is, the Chon-kul is nothing more than a wide expanse of land flooded by the Tarim; in all its western parts I observed a current, sometimes very considerable, towards the north-east. In this part the Tarim preserves an independent channel, although reduced to the size of a large ditch. Here the last two villages of Lob-nortsi are situated, and farther to the north-east lie boundless and impassable tracts of marsh-land, which actually absorb the remainder of the Tarim water. In these marshes, and in the great salt bogs extending, as the natives told us, far away in a N. E. direction, the standing water is doubtless salt, just as it is along the shallow western margin of the Chon-kul. — — — — — In conclusion, I consider it my duty to repeat, that the inhabitants one and all denied the existence of any other lakes in the neighbouring desert besides those on which they lived. — They likewise did not know of the oasis of »Gast», about which I had so often heard in Tsaidam.»

After the description which I have given of the lowermost Tarim and the Desert of Lop it will be unnecessary for me to examine these different opinions; I will therefore confine myself to calling attention to two or three points only. My second visit to the country of Lop in the years 1900 and 1901 has convinced me that von Richthofen's deductions agree with the actual occurrences that have taken place there in an even higher degree than what I believed in 1896. I ascertained that the Tarim formerly flowed due east along the bed which is called the Kuruk-darja, and that of this the Kontsche-darja was a tributary. At that time the Tarim emptied itself into »the true great Lob-nor». At a certain point, and for reasons which have yet to be set forth, an arm was sent off to the south-east, and subsequently, in the course of a year or two — or it may be after a long period, possibly several decennia — this branch received the entire volume of the Tarim and carried it down to the existing Kara-koschun, a lake which Richthofen identifies with the Khas-omo of the Chinese map. Previous to that the last-mentioned lake was fed exclusively by the Tschertschen-darja, and consequently must have been a very small and ephemeral lake, which only became filled at flood-time. However I doubt whether it was in the same place where we now find the Kara-koschun. It is more likely to have been a movable lake, and more probably coincides with the Kara-buran, and it was just as inconstant as the whole of the Tschertschen-darja delta is at the present time. Had the terminal reservoir of that river been stationary for any prolonged period, we should have found poplar forest along its banks; but forest is entirely absent throughout the whole of the lowermost parts of this hydrographical system, both beside the Tschertschen-darja and beside the Tarim.

Under *c* Richthofen adduces the only hydrographical measurement made by Prschevalskij; but I have left it out because it was not made with the requisite degree of accuracy.

Prschevalskij's reply to Richthofen's criticism was not perfectly convincing. He considered that the differences between the Chinese maps and his own discoveries were due to the unreliability of the maps. But the discoveries which I made in Lôu-lan and in the Desert of Lop prove, that the Chinese maps are perfectly correct. Indeed this was rendered in a high degree probable by Kosloff's discovery of the dry river-bed, the Kuruk-darja, the course of which agrees, according to my measurements, even in its details, with the course of the lowermost Tarim as depicted on the Chinese map.

Prschevalskij's remarks towards the close of his reply are quite correct, and possess the same justification to-day that they did when they were first made. The diminution in the volume of the Tarim is due to the drain made upon the stream by the marginal lakes and by evaporation. And he is quite right in saying that no small arm breaks away from the main river to empty itself into the ancient Lop-nor, for for several centuries it has received no influx of water. According to Prschevalskij, the reason of the water of the Kara-koschun being fresh is, that the lake can be regarded as a shallow area inundated by the river, and that a current can be detected everywhere throughout its western part. In this respect my opinion is in accord with the Russian traveller's. Throughout the whole of the northern stream, as far as one can row towards the east, the water is fresh, because there exists a current, which indeed may be regarded as a direct continuation of the river itself, and the river is considerably deeper than even the deepest part of the marsh. Along the southern stream we found that the water in the eastern basins was to a certain extent salt, owing to its being stagnant. If the basin of the Kara-koschun were more sharply defined as well as deeper, the entire lake would be salt; but the circumstances being as they are now, it *must* of necessity be otherwise. Everywhere where the reeds grow thickly and luxuriantly the water must be fresh, and the western part of the lake is rather an inland delta, where the waters spread themselves out in proportion as the lake grows shallower. A long way to the east we found few reeds near the northern shore, and the water there was so salt as to be scarcely drinkable. Still farther to the east it must be intensely salt, and it is hardly possible that there is any kamisch there. In these extreme eastern parts the water is stationary and evaporates, whereas in the west it is freshened up unceasingly by inflows from the river.

Richthofen's supposition under (*d*), »that there (south and west of Khas-omo) and not at Lob, lie the kingdoms of Leu-lan, Shen-shen, etc., which are named in history as situated near 'the salt lake'», is incorrect, at all events in so far as Lôu-lan is concerned, for I discovered the town of that name on the northern shore of Lop-nor. Grigorieff has given us a statement by the Chinese official and traveller Tschang-tsen (140—127 B.C.), telling us that such was the case. He says, »He (i. e. Tschang-tsen) calls attention to the Salt Lake (Lop-nor) which existed there

(East Turkestan), and estimates its distance from Tschang-an'i (at that time the capital of China) to be 5000 li (2,500 versts), and adds that all the rivers which flow east of Yü-tien (Chotan) empty themselves into that lake, and on its shores stand the towns which are subject to the kingdoms of Leu-lan and Gu-schi».[*] Rémusat, when speaking about the country of Niei-mo in his *Histoire de la Ville de Khotan*, in the chapter headed »Sous les Thang» gives from Chinese sources the following information, »Les villes sont entièrement désertes et le pays tout à fait dépeuplé. Plus loin, au nord-est, à mille li, est l'ancien royaume de Na-fo-po, ou le pays des Leou-lan»; to which Rémusat adds the note, »sur le lac de Lop.»[**]

Prschevalskij visited Lop-nor again during his fourth journey (1883—85), and spent no less than two months on its shores. In his account of this journey he says, »with regard to the existence of another Lop-nor along the continuation of the Tarim and east of the bend at the mouth of the Ugen-darja, a hypothesis suggested by Baron Richthofen in 1878, I will say, in addition to the reply which I wrote at the time, that we cross-questioned the people of Lop-nor exhaustively with regard to this matter, and they were unanimous in denying the existence of any such lake, and moreover they declared, that so far as local tradition reached back into the past, the lake beside which they were living had always occupied the same position.»[***]

The travellers who have visited the Lop-nor country since then, namely Carey and Dalgleish, Bonvalot and the Prince of Orléans, Pjevtsoff and his companions, and Littledale—all confirmed the accuracy of Prschevalskij's observations; but none of them, with the exception of the Pjevtsoff expedition, and particularly the labours of Bogdanovitsch, add to our knowledge of the country. *Petermanns Mitteilungen* was quite right, when as early as 1878 it stated that the Lop-nor problem could only be settled after fresh investigations made on the spot.[†] But, as I have already said, the new visits were unfruitful, and none of the travellers I have named, always with the exception of those of the Pjevtsoff expedition, seems to have been aware, that the position of Lop-nor had ever been a subject of discussion. It was for this reason that in the year 1896 I resolved I would not follow the usual route, but would travel east of all the waterways, so as to ascertain whether any canal did form a lake to the east, or not. This led to the discovery of the eastern waterway. In the lecture which I gave before various geographical societies, including those of Stockholm, St. Petersburg, and London, I was of course only able to refer to the problem in the briefest terms. But brief though my allusions were, they sufficed to put fresh life into the old dispute as to the position of the Lop-nor. I must therefore quote the following short passage from my address.

»On March 31 I left Tikkenlik. We found that Koncheh-darja divides, so that a part of its water goes to Chivilik-kul; but the larger portion, under the name of Ilek, runs south-east, and my satisfaction was great, when, on April 4, after following the left bank of the river for three days, I found that, just as the Chinese and Richthofen claimed, it empties into a long lake, whose eastern shore-line we followed for three days. The people living in the neighbourhood of Lop-nor call its four basins Avullu-kul, Kara-kul, Tayek-kul and Arka-kul, but the Chinese call the whole region Lob-nor, a name which, in the tract around the south lake, is absolutely unknown. I found the lake to run north to south, while the Chinese Lob-nor is mapped as running east to west. But even this circumstance has a natural explanation. Since the whole Lob-nor district lies nearly in the same horizontal plane, the hydrographical distribution must be extremely sensitive to any change in level. There are two constant factors effecting such changes, namely, the easterly sandstorms, which are especially violent in the spring, filling the basin and pressing the lake westward, and the sediment carried down by the river. That the lake formerly really extended eastward is shown by the fact that the eastern shore is skirted by a series of already isolated salty pools and marshes, as well as deep bays which will soon be isolated, and by a narrow belt of forest in which three separate growths may be distinguished—in the east, dried-up dead forest; in the centre, fresh forest with tall trees; and nearest to the present shore, young forest. Thus we see that the forest travels with the lake westward. The superfluous water continues through Sadak-kul and Nias-kul to the river Tarim. There are still other proofs that the southern lake must be of modern formation. It lacks every trace of forest, while the whole Tarim system, all the way down to the ancient Lob-nor, is very rich in poplars. The forest has not yet had time to extend to the new lake. Furthermore, the eighty-year-old Lob chief, Kunchikan-bek, told me that his grandfather, Numet-bek, had lived in his youth on the shores of a lake in the north, and that then there were only deserts to be found in the region of Abdal. Finally, I might mention that Marco Polo, who travelled through the city of Lob, does not say a word about any lake.»*

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[*] In V. V. Grigorieff's Russian translation of Ritter, published by the Geog. Soc. of St. Petersburg, Historical-geographical Appendix, part i., p. 19.

[**] Pp. 65—66. With regard to the historico-geographical notices about Lôu-lan, I beg to refer to Mr Karl Himly's and Prof. Dr. A. Conrady's essay on the subject in vol. VI of this work, while the topographical information will be found at the end of the present volume.

[***] *Ot Kijachty na Istoki Scholtoj Reki*, p. 294.

[†] Vol. XXIV p. 474.

My address to the Royal Geographical Society called forth a certain amount of criticism from Mr. Delmar Morgan, who after the paper spoke as follows: — — — »Now Dr. Sven Hedin, a pupil of Richthofen, has discovered a lake confirming the views of this eminent geographer, and he claims that this and no other is the true Lob-nor. After studying the arguments adduced by him in support of this conclusion, I must, with every respect to one who has personally visited the region in question, be allowed to differ, and I think it would be premature to alter the position of the lake on our maps before more complete surveys have been made, especially as a recent traveller, Mr. Kozloff, a member of Pevtsoff's expedition, passed through this country and made no change in the position of the lake, but, on the contrary, confirmed the general accuracy of Prschevalskij's observations. Among the arguments brought forward by Dr. Sven Hedin, he says that Marco Polo made no mention of the lake. But it is well known that Marco Polo mentioned very few of the natural features which he must have come across in his travels. Besides, the route he took would have taken him a considerable distance to the south of Lob-nor, and would have nearly coincided with that followed by Roborowsky and Kozloff in order to reach Shachau. These travellers speak of a vast extent of saline swamps, marking what must have formerly been the continuation in a north-easterly direction of the waterspread of Lob-nor. The ancient lake-bed is, according to their surveys, clearly defined by ranges of mountains to the north and south, meeting at some point to the north-east of Prejevalsky's lake.»*

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* *The Geographical Journal*, March 1898, Vol. XI, No. 3, pp. 240 ff.

Morgan, like Prschevalskij and Kosloff, never conceived the possibility of the Lop-nor being a migratory lake, which periodically changes its bed. They have conceived the Kara-koschun as occupying »a clearly defined bed», the margins of which, owing to the configuration of the adjacent country, the water was unable to overflow. It is clear that Prschevalskij, misled by the shrinking of the lake, was of opinion, that any fresh change in its bed was altogether inconceivable.

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* *The Geographical Journal*, April 1898, vol. XI, no. 4, p. 413, where my reply will also be found.

# CHAPTER XIX.

## THE LOP-NOR — KOSLOFF AND THE AUTHOR.

In what I have said in the preceding chapter I had no intention of making any contribution to the history of our knowledge of the Lop-nor; I only wished to arrange and bring together the contributions which have been made to the question of the situation of the lake. For the statements and experiences of other travellers, I beg to refer to *Petermanns Mitteilungen*, Ergänzhft No. 131.* Of my own observations I have already given an account in a letter from Chotan, written in 1896. To this letter ** Richthofen added a note, giving a *résumé* of the position of the Lop-nor question as it stood then, and this I venture to cite here, not only for its own sake, but also because it is a recapitulation of the general summary cited above. He says: — Es sei mir gestattet, diese Bemerkung durch eine kurze Darstellung der Geschichte des Lop-nor-Problems zu erläutern. Als Prschewalsky von seiner zweiten Reise zurückkehrte, habe ich in einem in der Gesellschaft für Erdkunde (am 6. April 1878) gehaltenen Vortrag an der Hand von Landkarten und alten chinesischen Urkunden zu zeigen gesucht, dass Prschewalsky den Lop-nor der chinesischen Karten nicht besucht habe, sondern einen anderen, um einen Breitengrad weiter südlich gelegenen, auf jenen als Khas-omo bezeichneten See, und kam zu dem Schluss »dass der Tarim früher nur einen östlichen Lauf nach dem wirklichen grossen Lop-nor hatte, in späterer Zeit aber aus der Gegend, wo sich ihm der Ugen-darya vereinigt, eine Abgrenzung nach Südosten erfuhr, welche der Hauptfluss wurde; dass dieser Zweig in den ehemals isolierten Khas-See mündete, diesen vergrösserte und zum Haupt-Reservoir gestaltete«. Der Vortrag wurde abgedruckt in den *Verhandlungen der Gesellsch. für Erdkunde zu Berlin* (1878, S. 121—144). — Als Herr Delmar Morgan bald darauf eine englische Übersetzung von Prschewalsky's Reise herausgab (*From Kulja across the Tian-shan to Lob-nor*, London, 1879), fügte er dem Werk auch eine Übertragung meines Vortrags bei (S. 135—159), sowie einige Bemerkungen, die ich an Sir Henry Yule eingesandt hatte (S. IV—V), und in denen ich ausführte, dass die Zeit der offenbaren Änderungen im Lauf des Tarim zwischen der Regierung Kiën-lung's, unter welchem die Karte angefertigt wurde, und der Jetztzeit liegen müsse. Ich fügte auch eine Kartenskizze mit vergleichender Einzeichnung der chinesischen und der Prschewalsky'schen Darstellung bei, welche in Delmar Morgan's Buch abgedruckt ist. Es sind letzterem ferner Bemerkungen zu meinem Vortrag beigefügt, welche Prschewalsky dem Verfasser des Buches auf seine Bitte zugesandt hatte (S. 160—165). Er (Prsch.) erhob darin energischen Protest gegen meine Ansicht, obgleich die Argumente derselben grossenteils seiner eigenen Darstellung entnommen waren. Indem er daran festhielt, dass der von ihm entdeckte Kara-koschun der wirkliche und einzige Lop-nor sei, kam er zu dem Schluss, dass die abweichende Fluss- und Seezeichnung der Chinesen, sowie die Beschränkung des Namens Lop-nor auf eine erheblich weiter nördlich gelegene Gegend, auf der Ungenauigkeit der geographischen Kenntnis der Chinesen beruhten. Da er selbst kein Wasser des Tarim nach Osten entweichen gesehen hatte, meinte er, dass dies zu allen Zeiten so gewesen sei. Das »Problem des Lop-nor», welches ich als ungelöst bezeichnet hatte, ist weiterhin nicht aufgehellt worden. Es sind zwar Reisende dem Lauf des Tarim gefolgt; doch schlugen sie den Weg von Prschewalsky ein. Infolgedessen stellte Herr Sven Hedin es sich zur Aufgabe, die Frage zu lösen. Er fasste diese richtig an, indem er sich den Beschwerden eines östlicher gelegenen Durchgangs von Nord nach Süd unterzog. Seine Beobachtungen und scharfsinnigen Folgerungen haben ihn zur Bestätigung des in der genannten Abhandlung angestellten Ergebnisses geführt.»

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* *Vide* the chapter entitled *Neuere Forschungen in der Lop-nor Gegend*, pp. 118—151.

** In *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, vol. XXXI. (1896), pp. 295—361.

In Richthofen's letter to Colonel Yule the following statements are of interest: »It appears evident — (1) that Prejevalsky travelled by the ancient road to a point south of the true Lop-nor; (2) that long before he reached this point he found the river-courses quite different from what they had been formerly; and (3) that following one of the new rivers which flows due south by a new road, he reached the two sweet-water lakes, one of which answers to the ancient Khas-omo. I use the word 'new' merely by way of comparison with the state of things in Kien-lung's time, when the map was made. It appears that the Chinese map shows the Khas lake too far north to cover the Kara-Koshun. The bifurcation of the roads south of the lake nearly resembles that which is marked by Prejevalsky» — — —.*

In the same Preface Delmar Morgan quotes the following passage from *The Athenæum* for the 14th Sept. 1878:

»It would appear that the Russian traveller Prejevalsky, in his last remarkable journey in the heart of Central Asia, did not explore Lob-nor at all, as he claims to have done. Baron Ferdinand von Richthofen, one of the first comparative geographers of the day, has examined the account of the journey more especially by the light of Chinese literature, and proves, almost incontestably to our thinking, that the true Lob-nor must lie somewhere north-east of the so-called Kara-Kotchun Lake discovered by Prejevalsky, and that in all probability it is fed by an eastern arm of the Tarim river. — — — The whole question is well worthy of further investigation» — — —.

Upon this D. Morgan comments thus: »On reading this it seemed to me that the writer had been a little too hasty in his conclusions, and that Colonel Prejevalsky might suffer an injustice were the statement allowed to pass without comment. I therefore wrote to the Editor of *The Athenæum*, saying that I thought the remarks contained in his paper were somewhat premature.»

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* See Preface to D. Morgan's book, pp. IV and V.

As it has turned out, the anonymous author in *The Athenæum* was right, and his statement was not premature. It is also interesting to read what the same author has to say 25 years later in a review* of my last book of travel. He says *inter alia:* »This conclusion** is satisfactory, not only because it attests the accurate discernment of a scientific traveller (von Richthofen), whose monumental work on China deserves to retain the admiration of geographers, but also because it bears out the trustworthiness, to a certain extent, of Chinese maps.»

I delivered precisely the same lecture, from which the passage about the Lop-nor cited above was taken, in St. Petersburg, and there my statements encountered the most energetic opposition, for practically all the Russian geographers who have occupied themselves with the geography of Central Asia combated their correctness, and maintained that Prschevalskij's views with regard to the Lop-nor were alone acceptable. The only ones who adopted a neutral attitude were Muschketoff, Pjevtsoff, and Bogdanovitsch, all men who count amongst those possessing the fullest knowledge of the geography of Central Asia. Shortly after my lecture Kosloff printed in the society's journal a substantial essay on the Lop-nor*** under the polemical title of »Lop-nor with Reference to Mr Sven Hedin's Lecture before the Imperial Russian Geographical Society on the 15th October 1897». In 1899 the same traveller published his work descriptive of the part he took in the expedition of 1893—95.† In this book he devotes almost an entire chapter to the Lop-nor, but unfortunately there is nothing new in it beyond what was contained in his essay; in fact this latter is printed word for word in the book, leaving out the long historical account. This surprised me, for in the course of the discussion to which I was invited in the topographical section of the Russian General Staff, I set forth more explicitly than I had done in my lecture the views which I held with regard to the Lop-nor question, several of my arguments being of such weight and importance that they might reasonably expect to receive some attention in the great and handsome book which Roborovskij and Kosloff soon afterwards published. Kosloff's energetic championship of Prschevalskij's views gave a fresh impulse to the dispute about the Lop-nor question, and marks the beginning of its second phase. But now that the problem has been solved, and a natural and simple clue has been found to the complicated hydrographical tangle, it may perhaps appear to many a matter of supererogation to rake up old quarrels, and adduce arguments *pro* and *con* (though these have now for the most part been deprived of their point). I repeat however, a re-survey of the various opinions which have been held is by no means without its interest, especially as it was the decided opposition of the Russian geographers, and especially of Kosloff himself, which more than anything else determined me to pay yet one visit more to the Lop-nor country, and carry out the survey which I have described in the preceding pages. Accordingly I will quote here Kosloff's latest contribution to the question, leaving out however those parts which have no direct bearing upon the matter.*

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* *The Athenæum*, 5th Dec. 1903.

** That is, the conclusion I arrived at in *Central Asia and Tibet* as to the Lop-nor question.

*** *Isvestija Imperatorskago Russk. Geografitschesk. Obschtschestva*, vol. XXXIV (1898), pt. 1 pp. 60—116.

† *Trudij Ekspeditsij Imp. Russk. Geogr. Obschtsch. po Tsentralnoj Asij*, pt. 2.

»In an ordinary meeting of the Imperial Russian Geographical Society Mr Sven Hedin, in his character of an active member of the society, delivered an address on the 15th October 1897 on his journey in the Pamirs, Kashgaria, the highlands of Tibet, and to Lop-nor. On the sketch-map, to which the Swedish traveller directed the attention of his audience, the last-named lake was shown one degree farther north than the position which, as is well known, the first European explorer of the Tarim basin, N. M. Prschevalskij, fixed for it by accurate astronomical observations.»

»On the map in question, two Lop-nors are represented; of these one, which is based upon doubtful Chinese sources, is given an immense area in the sandy desert, while the other, Prschevalskij's Lop-nor, which occupies the deepest salt depression, and the one that streches farthest north-east, is drawn very small, in fact it is hardly discernible, and — to crown all — is placed in a desert of continuous drift-sand.»

The map alluded to was a copy of Richthofen's map in Delmar Morgan's book; and the reason the Chinese Lop-nor was shown as covering »an immense area» is, that it was so represented on the original map. The only alterations I made in it were to add my own itineraries and those parts of the hydrographical system, especially the lakes, which I saw with my own eyes and to colour blue the portions of the Kara-koschun which are open water and free from kamisch.

Kosloff continues: »As I have myself visited Lop-nor three times, and as on the third occasion, in the winter of 1893—94, my itinerary touched the country of »Lob» on the north, the west, and the south, leaving but a narrow space on the north-east, it was only natural that, on the conclusion of Mr Sven Hedin's address, there should be an eager interchange of ideas between myself and the Swedish traveller with regard to the regions we had respectively explored.»

»I resolved therefore to confirm in black and white the views which I exchanged orally with Mr Sven Hedin with regard to his explanation of the Lop-nor problem; and at the same time to adduce in evidence the testimony of all who have visited the Lop-nor as to what they saw there. Further I will also cite the reply which Prschevalskij made to Baron Richthofen, so that the impartial reader may be able to form a clear idea of the present appearance of the Lop-nor, and — without going to the sources, which indeed are not readily accessible to everybody — may be in a position to determine which of the two is right — Prschevalskij, who identifies the historical Lop-nor with the existing lake, or Baron Richthofen, who maintains that the old Lop-nor, in agreement with the Chinese maps, must lie considerably farther north than the existing lake.»

In adducing in evidence the testimony of »all who have visited Lop-nor» as to what they saw there, Kosloff, curiously enough, omits the evidence of Carey and

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* In *Petermanns Mitteilungen*, Ergänzhft 131, pp. 143—149 I have already replied to a portion of Kosloff's essay on *Lop-nor*. It is obvious that, having crossed the Desert of Lop in several directions, I am now in a far better position than I was then to estimate the value of Kosloff's point of view.

Dalgleish, Bonvalot and the Prince of Orléans, and Littledale. This historical resumé — not that it really proves much — is omitted from the account of his journey.

›Let us turn‹, says Kosloff, ›to Baron Richthofen's reply. The Kara-koschun-kul is not the historical Lop-nor, says Baron Richthofen, because it contains fresh water, whereas the historical Lop-nor was a salt lake.»

»The Kara-koschun-kul does indeed contain fresh water; but, mark you, only in those parts in which there is an actual current entering from the Tarim—Jarkent-darja. On its outskirts, in the quiet bays, in a word everywhere where the water is stagnant, it is slightly saline, and farther east it is salt, sometimes intensely salt. This is proved by Prschevalskij, by Pjevtsoff, by the Prince of Orléans, and by Sven Hedin himself; and to their testimony I am able to add my own. The greater the distance from the point where the Jarkent-darja enters the Kara-koschun-kul, the salter grows the water, until at last even the camels no longer venture to drink it. The desiccated parts of the lake-bottom are impregnated with salt, and its shores all round are salt for a considerable distance back. All this is in agreement both with the historical facts and with the requirements of theory. Hence, from this point of view, there is nothing to prevent us from regarding the Kara-koschun-kul as the historical Lop-nor.»

This account of the salinity relations of the lake are perfectly correct, as I have already shown when relating the investigations I made on the northern and southern shores of the Kara-koschun. But when Kosloff maintains that the Kara-koschun is the Lop-nor which the Chinese formerly called *the Salt Lake*, on the ground that it possesses the requisite salinity, then I say at once, that that is an erroneous view. Seeing what the Kara-koschun is like now, no Chinese, let alone any other person, would entertain such a mad idea as to call it a *salt lake*, for it is just those parts of the lake which are inaccessible and are never visited that happen to be salt. The route to Sa-tscheo runs, I grant, along the southern shore, where the water is indeed salt; but even there you have only to send, as I did, one or two Lopliks on foot into the lake with buckets to get perfectly fresh water. In case of need too it is possible to drink the water along the shore. Any way, as compared with other salt lakes in Central Asia, the Kara-koschun deserves rather to be called a freshwater lake. It is also significant, that the first European who visited the lake calls it a freshwater lake. It is little likely therefore that the Chinese have ever called the Kara-koschun a salt lake.

›On the Chinese map, and in the Chinese essay *Si-yü-schuei-tao-ki*, Lop-nor is placed a full degree north of the Kara-koschun-kul. Very good; but it is an error, and here are the reasons why it is so.›

»The geographical coordinates for Ajrilghan near the confluence of the Kontsche-darja with the Tarim were determined by the same Jesuits, Hallerstein and d'Espinha, who also determined the positions of Korla and Kara-schahr. According to their observation, Ajrilghan lies in 40° 2′ N. lat. and 87° 23′ E. long. (from Greenwich) — according to M. V. Pjevtsoff in 40° 8′.7 N. lat. and 88° 20′ E. long. — that is to say only 6′.7 farther south than it actually lies, which undoubtedly speaks well for the accuracy of both the Jesuits' and Pjevtsoff's Ajrilghan. In other words, the confluence of the Kontsche-darja and the Tarim lay, even at the time when the Jesuits fixed its position, a good deal farther south than the position in which the

Chinese maps put Lop-nor. Moreover that position is a long way north of the present mouth of the Tarim, and even ninety years ago the river discharged only 4 versts west of the place where it discharges now. Two hundred years ago the Jarkent-darja flowed in the bed now called the Schirge-tschapghan, which starts in the district of the same name 25 versts above Tschigelik, but 40 versts south of Ajrilghan. Consequently, at the time when the missionaries I have named visited Ajrilghan, the Lop-nor existed where the Kara-koschun-kul does now. It is evident the compiler of the Chinese map, upon which Baron Richthofen relies in his reply, failed to bear in mind the position of Ajrilghan as determined by the Jesuits.»

This passage does not prove that Richthofen was wrong in the arguments he adduced, and still less does it prove that the Chinese map is wrong in placing Lop-nor one degree north of Kara-koschun. With regard to the final inference, that at the time of the journey of the two Jesuits the Lop-nor was situated where the Kara-koschun is — that is perfectly self-evident, a fact to which I myself called attention in my first letter from Chotan. From this letter I must here quote the following passage:

»Folgende wichtige Mitteilung erhielt ich von Kuntyeckan-Bek. Er selbst ist 80 Jahr alt. Sein Vater, Dyahan-Bek, starb vor 23 Jahren in einem Alter von 90 Jahren. Sein Grossvater, Numet-Bek, starb 95 Jahre alt, da Dyahan noch jung war. Dieser Numet wohnte an einem grossen und mehreren kleinen Seen, die sich nördlich vom jetzigen Lop-nor ausbreiteten und mit ihren südlichen Ausläufern bis einige Kilometer vom heutigen Abdal reichten. Das Wasser dieser Seen kam von einem Punkt irgendwo zwischen Kulatscha und Nias-köll, von welchem der Tarim sich damals gegen Osten wandte; dieser floss bei Merdek-Schahr vorüber, und die Seen erstreckten sich gegen O und SO. Als Numet-Bek ungefähr 25 Jahr alt war, trocknete dieser Tarim allmählich aus, und der Fluss suchte sich ein neues Bett. Dieses neue Bett war dasselbe, welches man mir in Tschigelik-uj Ettek-Tarim, d. h. der Westliche, nannte. Es strömte durch die heutige Wüste gegen die Niederlassung Lop, um dann in den Kara-buran zu münden. Der Ettek-Tarim soll noch vor 45 Jahren ein wenig Wasser geführt haben, was Kuntyeckan-Bek selbst gesehen hat. Dieser Fluss, der heutzutage ganz und gar trocken ist, ging von Arghan aus. Damals gruben die Lopliks bei Arghan tyappgans, um kleine Seen zum Fischfang zu bilden. Diese künstlichen Kanäle mögen es veranlasst haben, dass der ganze Fluss sich ein östlicheres, das jetzige Bett, einschnitt. Hiervon stammt der Name *Arghan* oder *Ayrilghan* (Bifurkation, Teilung eines Flusses oder eines Weges), ein Name, der heute hier gar keinen Sinn hat für einen Ort, wo sich vielmehr zwei Flüsse vereinigen, und wo wir also lieber den Namen *Koschlasch* erwarten möchten, wie beim Zusammenfluss von Kara-kasch und Yurun-kasch, oder von Khotan-darya und Yarkent-darya. Nichtsdestoweniger bleibt noch der Name bestehen wie ein Beweis für die frühere Existenz des Ettek-Tarim. Wie soeben erwähnt, trocknete gleichzeitig mit der Bildung des Ettek-Tarim das alte, nach Merdek gerichtete Bett aus, ebenso sämtliche daran gelegene Seen, und das Wasser ging im Bett des Ettek gegen Süden, um den neuen Lop-nor zu bilden. In einem Alter von 25 Jahren verliess deshalb Numet-Bek mit seiner ganzen Umgebung Kovna-Abdal (»das alte») und begab sich zum heutigen Abdal, dessen Grund er selbst gelegt hat. Sein Vater, Mattias, und der Vater desselben, Yssym-kullu, hatten beide in Kovna-Abdal gewohnt; weiter zurück aus der Vergangenheit wusste Kuntyeckan-Bek nichts zu berichten. Nach diesen geschichtlichen Daten, die natürlich nur mit Vorsicht aufzunehmen sind, würde der südliche Lop-nor vor etwa 175 Jahren oder ungefähr im Jahr 1720 gebildet sein, ein Resultat, welches ich, wenn ich es mit den physisch-geographischen Thatsachen vergleiche, für wahrscheinlich halte.»*

To this Richthofen added the following note:

»Dr. Hedin's Berechnung scheint, auch wenn man die Angaben seines Gewährsmannes im allgemeinen als richtig annimmt, zu weit zurückzuführen. Denn wenn Numet im Jahr 1720 ein Alter von 25 Jahren hatte und sein Sohn 1783 geboren wurde, so hätte sich dies im 88. Lebensjahr des ersteren ereignet. Wahrscheinlicher dürfte es sein, dass Numet nicht vor 1750 sein 25. Lebensjahr erreichte und die hydrographische Änderung um diese Zeit sich ereignete.»**

In Pjevtsoff we find the following explanation: »Out of the 34 points the positions of which I fixed, eight had already been determined by the Catholic missionaries, of the Jesuit order, Hallerstein and d'Espinha, in the reign of the Chinese emperor Tsjan-lun, in the years 1760—65. What instruments they used, and what method they followed, in determining their geographical coordinates is not known. All we know of their work is merely the list of points determined, together with their latitudes and longitudes.***

Richthofen tells us, that about the middle of the 18th century the Emperor Kiën-lung incorporated a considerable part of Central Asia into his empire, and wished to have a map of it made. »Zu diesem Zweck wurden zu wiederholten Malen die portugiesischen Jesuiten Espinha und d'Arocha ausgesandt, denen später der Deutsche Hallerstein beigesellt wurde. Die Aufnahmen, welche sie theils selbst machten, theils durch geschulte Chinesen ausführen liessen, verdienen Anerkennung wegen der mässigen Grösse der Irrthümer in den Positionen, um so mehr als es scheint, dass sie keine Instrumente für die Längenbestimmungen gehabt haben.»†

If now, as the local tradition avers, the Kara-koschun was formed about the year 1720, or at the latest 1750, then it is perfectly obvious, that the lake occupied its present position at the time of Hallerstein and d'Espinha's visit, i. e. between 1760 and 1765. If on the other hand the Ajrilghan of the Jesuits is identical with Prschevalskij's Ajrilghan, or rather Arghan, then the view I have expressed as to the origin of the name in the passage quoted above is wrong. It is however extremely unlikely that the name refers to one and the same point of bifurcation, especially as the existing Ajrilghan is not a bifurcation, but a *koschlasch*, or »confluence», of several rivers. On the other hand the name Ajrilghan is very common throughout the whole of the Tarim system. Everywhere where a river divides into arms, or even where a canal breaks away from a main stream, there we have an *ajrilghan* or *arelisch*. It is not probable that the actual confluence of the Tarim and the Kontsche-darja has occupied the same position for 140 years; it is even likely that it alters a little every year. So far as one can see however, it did occupy the same position in 1876, and the rivers in the vicinity of Ajrilghan presented then on the whole the same appearance that they had in the year 1900. At all events in the years 1760—65, the Kara-koschun occupied the basin it now occupies, just as Kosloff says, basing his statement upon information supplied to him by the learned General Stubendorff, than whom no man is more skilled in Central Asian cartography.

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* *Zeitschrift d. Ges. f. Erd. zu Berlin*, vol. XXXI (1896), pp. 340—341.

** *Loc. cit.* p. 341.

*** *Trudij* etc., p. 398.

† *China*, vol. I. p. 690.

Kosloff's statement, that two hundred years ago the Tarim flowed through the Schirge-tschapghan arm is taken from Pjevtsoff,[*] who writes thus: »According to tradition the Jarkent-darja flowed 200 years ago farther to the north than its present lowermost course, and discharged into the little lake of Utschu-kul, which was connected with the Lop-nor by a sound. This tradition was confirmed by old Abdul Kerim, who said that in his grandfather's lifetime the river still flowed through the place named, but subsequently it changed its bed. The old bed of the Jarkent-darja, now called Schirge-tschapghan, can be distinctly traced even at the present time. Beside it there still remain in places stumps of trees, which once shaded its banks. Formerly these tree-stumps were very numerous, but the inhabitants of the neighbouring villages having consumed them as fuel, they are now far fewer in number.»

I have already shown, that during the last few years a considerable portion of the Tarim returned to the bed of the Schirge-tschapghan (Tokus-tarim), and that old tree-trunks which once accompanied that river extend into those parts of the Desert of Lop where I crossed it. Pjevtsoff's statements are always characterised by the greatest accuracy and conscientiousness, and he would not have written down the information of Abdul Kerim, unless he was convinced of its reliability. Moreover I am able to confirm it with maps and my own observations made on the spot. It is interesting to see how well Pjevtsoff's conclusions, based on questions he addressed to the natives, agree with those which I arrived at in 1896, and which are incorporated in the passage quoted above from the *Zeitschrift*. Pjevtsoff says, that his informant Abdul Kerim was 110 years old in 1890. Consequently he was born in 1780. Supposing his father to have been 40 when he was born, his birth would fall in the year 1740; and if *his* father was 40 when *he* was born, the grandfather's birth would take place in 1700. Now it was from his grandfather that Abdul Kerim derived his information. This ancestor seems also to have lived to an exceptionally great age; perhaps he was not born until 1720, in which case the two figures 40 must be altered to 30. The change of river-bed must have taken place in 1740 at the latest. Pjevtsoff says indeed, that it was in Abdul Kerim's »grandfather's lifetime», and since Abdul Kerim, who was born in 1780, derived his information from his grandfather, we are brought to the interval between 1700 (or 1720) and 1790—95, when Abdul Kerim was old enough to discuss the matter with the old man. But if that were so, Abdul Kerim might very well have told Pjevtsoff that he himself, or at any rate his father, was alive when the river changed its bed. But as an actual fact it was only the grandfather who was alive when that event took place; consequently it must have occurred about the year 1740. My information was derived from a different person, namely Kuntschekan Bek, and it carried us back to the year 1720 as the date of the change in the river-bed — a date for which Richthofen rightly substituted 1750. Hence it is the same tradition upon which both Pjevtsoff's calculations and my own rest, and there exists no reason to doubt its trustworthiness. The course of the lowermost Tarim from Schirge-tschapghan, *via* Tschigelik-uj, Kara-buran, Jurt-tschapghan, Abdal, and right on down to Kum-tschapghan is therefore a new creation, dating from the year 1740 or thereabouts. Previous to that that region was, as the existing vegetation proves, a desert, or at the most a scanty steppe-land. It is possible, indeed probable — though by no means indispensable — that the Kara-koschun had even then approximately the same position as now, excepting only the more northerly lake of Utschu-kul and its generally greater extent. This is of course on the assumption that the lake was not, as it is now, undergoing a process of shrinkage, followed by one or more periods of increase and expansion. On the other hand the observations of Hallerstein and d'Espinha have nothing in the world to do with the matter, for in any and every case the Tarim did flow past the present Ajrilghan, or at any rate in its immediate vicinity.

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[*] *Trudij* etc., p. 305—6.

If now the lowermost Tarim from Schirge-tschapgan downwards has occupied its existing bed for about 160 years, and yet no toghrak forest has succeeded in springing up along its banks, the question arises, how long did the river need to occupy the bed of the Tokus-tarim (Schirge-tschapghan) before the forest which stood beside it attained the maturity and development exhibited by the decayed tree-trunks? If it is permissible to argue from analogy, one would reply — A very considerably longer period than 160 years. This river-arm originated probably in the beginning or middle of the 16th century, unless the spread of the forest to its banks was helped by exceptionally favourable circumstances. The lowermost Tarim would appear however, at all events for a time, to have been divided into several arms, for I was told that the northern lakes (Pjevtsoff's Utschu-kul) likewise derived their water from a point between Kulatscha and Nias-köl. If, when we consider the hydrographical relations of this flat region, we assume the century as our unit of time, it results that the changes effected here must be beyond the bounds of conception. I have myself seen how a single year will suffice to render a radical alteration necessary in the map. Unfortunately the historical data we possess with regard to the Lop country are extremely meagre; and yet it is inevitable that it should be so. Of the changes that do take place it is only exceptionally that the effects remain impressed upon the face of the country. In general they are relatively soon obliterated through the effects of the wind and the levelling agency of the river-sedimentation. It is only in imagination that the traveller who has traversed the country of Lop in various directions can venture to take a hurried glance backwards down the centuries, and during the last two thousand years picture to himself a fresh map at the turn of each succeeding century. It is only from the sources and down to the district of Karaul that a series of maps such as this would give us a tolerably permanent picture of the course of the Tarim; and yet even there pretty thoroughgoing changes have taken place during the last few years. Below Karaul however the maps would reveal a very restless and inconstant stream. There exists no reason to suppose that the Lop-nor flitted over to the Kara-koschun all at once, by a single operation so to speak, and that it is »*this* flitting over» which took place in the year 1740. The last occurrence was merely one step, one moment, in a whole series of hydrographical changes. Indeed, thanks to the *Si-yü-schuei-tao-ki*, from which in 1899 Mr Himly was so kind as to translate for me everything relating to Lop-nor, we see that names which are still retained in the country existed as early as 1722. We read there, »Beim Einfall der Söngaren wurden, als das erste Heer 1722 nach Turfan kam und es befestigte, die unter Ghurban stehenden Lop-nur-Türken von Kara-kul, Satak-tu, und Kara-khodscho, über 1000 Leute, die sie Land haben wollten, einverleibt.»* The names Kara-köl, and Sadak-köl, and Kara-koschun still exist, though we do not know whether they refer to the same places as in the year 1722.

Kosloff is perfectly right in suspecting, that the compiler of the Chinese map was ignorant of the position of Ajrilghan as fixed by the Jesuits. For my own part, I will go a good deal farther than he does, now that my knowledge of the country has been extended, and I have been compelled by facts to change to some extent the views which I expressed in 1896. I believe therefore that the compiler of the Chinese map was ignorant not only of the Jesuits' labours, but also of discoveries made by many Chinese before their time. For, allowing that the last change took place about 1740, there certainly existed a lake in the southern part of the desert before the year named, and of that fact the Chinese cartographer was equally ignorant. The lake in question was situated just about where we may suppose Pjevtsoff's Utschu-kul to have been, at any rate a good deal farther south than the ancient Lop-nor. But the greatest and most radical change of all, one which resulted in the sweeping of several inhabited places from off the earth, in the emigration of entire tribes of people, in the abandonment and complete forgetfulness of ancient highways, in the dying out of entire forests, nay in the disappearance of a complete kingdom — namely the desiccation of the ancient Lop-nor — that is an occurrence which took place a very long time ago, at an era to which no traditions reach back, but which nevertheless actually did occur, as I fortunately am able to prove not only by documentary evidence, but also by facts, that speak a language sufficiently distinct. With regard to this Mr Himly says in his Preliminary Report entitled *Sven Hedins Ausgrabungen am alten Lop-nur:*** »Es ist nach dem allen kaum zu bezweifeln, dass hier das alte Lôu-lan war und am alten Lop-nur lag. — Diese alte Stadt scheint Anfang des vierten Jahrhunderts vom Wüstensturm oder von den Gewässern, bzw. durch beide Gewalten zerstört worden zu sein. — Man wird in der Nähe eine andre, die sogenannte Drachenstadt gebaut haben, welche dann ihrerseits in den Jahren 1308—11 durch eine Sturmflut zugrunde ging.»

The force of nature by which the destruction of Lôu-lan was brought about was neither desert-storm nor flood of water, but simply the drying up of the lake. It is indeed conceivable, that a portion of the country of Lôu-lan may have lain on the southern shore of Lop-nor, and that the lake may itself in part have moved south in the same way as the Kara-koschun is now travelling towards the north; but as I discovered the ruins of the town of Lôu-lan on its northern shore, it must have been the desiccation itself that occasioned the town to be abandoned. If however it was possible to build the Dragon Town in the vicinity of Lôu-lan, the change in the lake which led to the desertion of the latter town cannot have been of any great consequence. And if the great change, the disappearance of the Lop-nor, took place in the beginning of the 14th century, then unquestionably it took place two hundred years before the Jesuit order was founded, so that the journey of Hallerstein and d'Espinha, and their topographical determinations, have nothing whatever to do with the solution of the Lop-nor problem. Still less ought we to use their determination of the position of Ajrilghan, in the way Kosloff does, as a proof that the Lop-nor and the Kara-koschun are one and the same lake. From what I have said above, Kosloff's statement is perfectly self-evident, when he says, that »the confluence of the Kontsche-darja and the Tarim lay, even at the time when the Jesuits fixed its position, a good deal farther south than the position in which the Chinese maps put Lop-nor.» But when he goes on to add, »Consequently, previous to these missionaries' visit to Ajrilghan, the Lop-nor existed where the Kara-koschun-kul does now», he is guilty, in the first place of drawing a false conclusion, and in the second place of jumbling together things which have no connection with one another, for the situation of the Lop-nor cannot ever have coincided with the Kara-koschun, neither at the time of the Jesuits' visit, nor at any other time either before or since. The Lop-nor was situated in the northern part of the desert; for at least 160 years past the Kara-koschun has been in the southern part of the desert. At the time when the Lop-nor existed, the Kara-koschun did not exist, and now, since this latter lake has been formed, the former has dried up. In other words, they are two perfectly distinct lakes we have to deal with. Had Kosloff worded his sentence thus, »At the time of the Jesuits' visit to Ajrilghan the Tarim emptied itself into the same terminal lake that is now called the Kara-koschun», he would have been perfectly correct.

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* *Peterm. Mitteil.*, Ergänzhft 131, p. 153.

** *Peterm. Mitteil.*, 1902, Heft XII, p. 290.

Continuing my quotations from Kosloff's book: — »Further, Baron Richthofen says, that the Chinese map shows south of Lop-nor nothing but flat lowlands, while the mountains, which answer to the Altin-tagh, are, according to Baron Richthofen, placed south of the lake of Khas-nur.»

»On the accompanying Chinese map,* I repeat, the same map which Richthofen used as the basis of his reply, we see, south of Lop-nor, the word »Nukitu-daban». Now *daban* means »pass»; hence at the place indicated by this word there exists a pass. And even on Chinese maps you do not find, Baron Richthofen tells us, anything that does not really exist. That is to say, between the lakes Lop-nor and Khas-nur there are mountains; and in fact we have a confirmation of this in V. M. Uspenskij's essay, »*The Country of Kuke-nor and Tsin-hai*,** which is based upon Chinese sources.» Then follows, as in *Lop-nor*, a quotation from Uspenskij's translation. Instead of requoting this passage, I will use the translation of the same passage, which at my request Mr Himly made in 1899; it is more accurate than Uspenskij's.*** In the third part of the *Si-yü-schuei-tao-ki*, pp. 22 *b*—23 *a*, which treat of Edsinei and Kara-nur, we read:

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* By Wegener and Himly (see below).

** *Sapiskij Imp. Russ. Geogr. Obschtsch. po Otdjel. Etnografia*, vol. VI. pp. 57—196 (St. Petersburg, 1880).

*** See above *Peterm. Mitteil.*, Ergänzhft No. 131, p. 145.

»Der (Kara-)'nur' ist von Osten nach Westen 80 li, von Süden nach Norden 30 li gross und liegt auf 39° 46' N. Br., 23° 35' bis 24° 3' W. L. und ist vom Lop-nur 800 li weit entfernt. — — — Der 'nur' ist mit dem Lop-nur im Westen durch zwei Wege verbunden. Auf dem südlich vom 'nur' befindlichen kommt man von Bayan-bula(k) 200 li westlich nach To-pu-kou (kou chinesich Bach?), 150 li weiter nach Südwesten nach Khulu-sutai, 730 li noch weiter westlich nach Tsaghan-tschilaotu, noch über 300 li weiter nach Westen nach Ulan-tologhai, weiter westlich bis zur Ostseite des Khas-nur, weiter nach Norden nach Khu-pu, noch weiter nördlich bis zum Süden des Nukitu-daban (Nukitu-ling), nach einer westlichen Wendung nach Nukitu-setsin, noch weiter westlich nach Nukitu-schan-k'ou (d. i. Mund des Nukitu-Gebirges oder Berges, also die nördliche Thalmündung), zusammen über 300 li, weiter westlich vom Südufer des Lop-nur aus gelangt man nach Ike-Gaschon, und noch weiter westlich nach Baghan-Gaschon, welches das südliche Ufer des Tarim-Flusses ist.»

To this translation of the Chinese original Himly adds the following note: »Des Verfassers Aufzeichnungen scheinen zu sehr verschiedenen Zeiten gemacht zu sein, und wie das dritte Heft auf die beiden ersten folgt, die vom Lop-nur und seinen Zuflüssen handeln, wird der Verfasser zur Zeit, wo er über den Khara-nur schrieb, besser Bescheid gewusst haben. Der Baga-ghaschon ist offenbar einer der vier kleinen südlichen Seen; ghaschon ('bitter') war er wohl, ehe der Tarim-Fluss hineinfloss. Nun möchte der Tarim-See aber wohl auch dahin zu verstehen sein, dass der Tarim-Fluss seinen Lauf dahin genommen hat. — — — Rätselhaft sind die Umwege, die gemacht werden. Vom Kas-See aus handelt es sich doch entschieden um Gebirge.»

To the Chinese quotation Kosloff appends the following observation: »A few lines earlier we have an allusion to the mountain of Nutsitu, which lies between the lakes of Kasi-nor and Lob-nor. Hence it clearly follows that, under no circumstances, can the lake of Kasi-nor or Khas-omo be identified with Kara-koschun-kul, and inasmuch as Lop-nor lies — as it evidently does both from the description and from the map — at the northern foot of the mountain Nutsitu, the Kara-koschun-kul, which Prschevalskij recognises as the Lop-nor, is in reality the historical Lop-nor.»

»With regard to Richthofen's Khas-omo, the Khas-nur of the Chinese map, it corresponds without doubt to Prschevalskij's lake Gas, as General Stubendorff, the chief of the department for military topography of the General Staff, showed Mr Sven Hedin the day after his lecture before the Imperial Russian Geographical Society. It is true, this lake lies farther south than it is represented on the Chinese map, namely in 38° 7' N. lat., whereas on the Chinese map it appears at 39° 50' N. lat. Let us assume that the coordinates of Gas-nor are taken from the map which accompanies N. M. Prschevalskij's fourth journey; but the point of intersection between the river Utu-muren and the route by which Prschevalskij travelled from Tsajdam to Lop-nor in 1885 lies in 36° 55'.8 N. lat., 93° 13' E. long. from Greenwich, whereas on the Chinese map it is 38° 30' N. lat. and approximately 90° 27' E. long. If now on the Chinese map we transpose in a corresponding manner the positions of the river Utu-muren and the lakes Gas-nor and Lop-nor, and transfer to the position of the towns of Korla and Schah-jar the district of Ajrilghan, that is to say the confluence of the Jarkent-darja and the Kontsche-darja, as well as the middle course of the former river, we obtain the whole of the arc of the lower Tarim, the upper two-thirds of which, notwithstanding the representation of the Chinese map, has existed for at least 200 years, as is clear from the local traditions which M. V. Pjevtsoff gathered.

In this way the objections of Baron Richthofen and Mr Sven Hedin, which are built up upon the Chinese map, fall to the ground; and the same applies to Mr Sven Hedin's ingenious hypothesis set forth on pp. 201—205 of vol. XLII (1896) of *Petermanns Mitteilungen*, under the title of *Ein Versuch zur Darstellung der Wanderung des Lop-Beckens in neuerer Zeit*, which has been reproduced since then by a number of Russian and foreign journals.»

»With regard to the second unnamed lake which is shown on the Chinese map as lying west of the Khas-nur, it will represent either the Ajagh-kum-kul or perhaps the Tschong-kum-kul; though for our present purpose it is immaterial whether we identify it with either the one or the other of these lakes. In any case it does not represent the Kara-buran, because the Chinese map shows a mountain at the eastern end of this lake, whereas in reality there are no mountains on the east side of Kara-buran.»

»The Kara-buran, as well as the Tschertschen-darja, which falls into it after a course of 600 versts, was plainly unknown to the compiler of the Chinese map, who was also ignorant of the oases of Tschertschen and Nija.»

This interesting and ingenious examination, in which General Stubendorff's experience peeps out strongly, was already printed in Kosloff's essay entitled *Lop-nor*. The point we are now discussing, the interpretation and identification of the Khas-nor (Khas-omo), seemed to me to be almost practically solved in 1899, when I wrote with regard to it: »Nach dieser chinesischen Beschreibung scheinen freilich Stubendorff, Grigoriew, und Kosloff recht zu haben, allein ich bin jetzt nicht in der Lage, diesen Punkt der Lop-nor-Frage zu entscheiden.» Baron Richthofen, to whom I wrote about the matter, was unable to recede from his opinion, and replied to me as follows, a reply which I quoted afterwards in *Peterm. Mitteil.*

»Ich bin jetzt fester als jemals zuvor von der Richtigkeit Ihrer und meiner Ansicht überzeugt. Angesichts aller Thatsachen erscheint es mir völlig haltlos, den Khas-omo der chinesischen Karte mit dem Gass-See von Prjevalskij zu identifizieren. Da muss man doch der chinesischen Karte Gewalt anthun, die sie nach meinen Erfahrungen nicht verdient. Dagegen liegt die Identifizierung von Kara-koschun und Khas-nor völlig klar, sowie man das Ganze der Karte ins Auge fasst.»

I repeat once more, that all this discussion about the Chinese map is superfluous, now that we know from my latest explorations what was the exact site of Lôu-lan, the city which was situated on the shore of the »Salt Lake». In consequence of this discovery the proofs which Kosloff adduces with such an air of triumph and such consciousness of victory lose their point entirely, and the only interest attaching to this question of the Chinese map is, that it teaches us how far we may on the whole repose confidence in a Chinese map. It is simply for this reason, that I am about to dwell for a moment upon the above-quoted passage from

Kosloff's book, for it is not calculated to throw much light upon the Lop-nor problem; besides, that problem is now solved.

When Kosloff asserts, that the hypothesis put forward by Richthofen and myself is untenable, as being »built up upon the Chinese map,» I would point out that he has hardly any other grounds for assailing the view taken by Prschevalskij and myself than such as are drawn from the same Chinese map, the map which he found in Wegener and Himly's paper in the *Zeitschrift.** Since now we have two great authorities opposed to one another, interpreting the same original sources each in an entirely different way — Richthofen, with his long experience of the excellence of the map in question, employing the data it offers to prove that the Khas-omo is identical with the Kara-koschun, and Stubendorff, with his long special experience as head of the topographical section of the Russian General Staff, using precisely the same data to prove that Khas-omo is identical with the lake Ghas in Tsajdam — well, one does not very well know on which side to put oneself.

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* See *Zeitschr. d. Gesellsch. für Erdkunde zu Berlin*, vol. XXVIII (1893).

# CHAPTER XX.

## THE LOP-NOR REGION ON THE WU-TSCHANG-FU MAP.

To judge from the passage quoted above from the *Si-yü-schuei-tao-ki*, which has been translated by Himly, and before him by Uspenskij, it is perfectly clear, that the lake of Khas-nur mentioned therein is situated among mountains and south of an actual mountain-chain. To me also it no longer admits of any doubt, that the Khas-nor of the Chinese map cannot be any other lake except the Tschimen-köl (Turkish) or Ghas-nor (Mongolian), discovered by Prschevalskij in the easternmost part of the valley of Tschimen, on the border of Tsajdam, and generally called by him simply Lake Ghas, a lake which I myself visited subsequently on two separate occasions. On this point I am convinced that Stubendorff and Kosloff are quite right; both the text quoted and the Chinese map make it impossible for me to identify the Khas-nur with the Kara-koschun. The map alone would not have been sufficient to justify this conclusion, for it shows no mountains to the north of Khas-nur, and the name »Nukitu-daban» taken by itself is not sufficient to prove the existence of a mountain-range. For the word *davan* has with the Lopliks a more elastic and wider meaning than it has, for example, with the Kirghis and the Taghliks. The first-named would apply the term to a small notch or saddle in a sand-dune only 3 to 4 m. high, and on one occasion (see vol. I p. 341 above) I came across a district in a perfectly flat country called simply ***Davan***. To judge from Wegener and Himly's reproduction of the map in question, which was published at Wu-tschang-fu in 1863, one would be led to very erroneous conclusions if one were to rely without criticism upon the presence or absence of the blunted angles which are there used to indicate mountains. Richthofen says also, »Orography is the weakest point of Chinese maps. Where a mountain is marked there is certain to be one; but it is impossible to say, whether it be high or low, steep or rounded, continuous or isolated. The boundary, however, between hill country and lowlands can in most cases be approximately traced.»*

On the Wu-tschang map however there are mountains depicted which do not exist at all. For instance, it shows numerous mountains in the interior of the Tsajdam depression, where such elevations as do in reality exist hardly deserve to be called hills. On the other hand the mountain-range to which the Nukitu-daban belongs is not even represented on the map. But the height of absurdity is reached when mountains are put in the Ta Gobi, in that part of it which I crossed on my way from the Kerija-darja to the Tarim; for there does not exist there the slightest trace of a mountain any more than there does in the desert immediately north-east of Kerija. The fact of the signs for mountains being shown in these places must therefore be due either to the private belief of the cartographer, or to erroneous information given to him, or — and this is probably the most likely explanation — he intended by those signs to indicate the lofty sand-dunes which do exist there. Consequently from the occurrence of the conventional Chinese cartographical signs it is impossible, as von Richthofen points out, to conclude whether they mean mountain-chains capped with perpetual snow or whether they are merely low hills. The Chinaman in fact has so little appreciation of the relief of a country and of the plastic features of the earth that he does not make the slightest difference between a hill 50 m. high and a mountain 5000 m. high, taking both altitudes relatively. On the other hand, for horizontal topography he has a keen eye and a wonderfully developed power of apprehension. At the same time it is obvious, that a map may err in point of topography. In certain parts of the Wu-tschang map the errors are practically insignificant, because the materials from those regions are much more abundant than from the parts with regard to which the Chinese possessed only imperfect *data*. For instance, Khas-nur is placed too far to the north, and 1½° too far to the west, the consequence being that the southern road from Sa-tscheo is pushed too far to the north. As for the road from Khas-nur to Lop-nor, it is not possible to draw any conclusion whatever from the account given in the *Si-yü-schuei-tao-ki*, for that carries us continuously west from the pass of Nukitu-daban, whereas Lop-nor lies north of that position. In fact the map gives a much nearer approximation to the truth than does the description in the accompanying text; for according to the former Khas-nor lies at any rate south-south-east from Lop-nor, although the distance is much too short, but the text puts it east of Lop-nor. There can be little doubt that information dating from different periods, and derived from different authorities, has been collected and pieced together. The impression left upon the mind is that as far as Nukitu-daban the writer is describing the southern road, but from that point onwards he is describing the northern road. For he says, »after leaving Nukitu-daban you keep to the west and then come to Nukitu-setsin, and still going west you come next to Nukitu-schan-k'ou, and on beyond that until you touch successively the southern shore of Lop-nor, the Ike-ghaschon, and, still farther on, the Baghan-ghaschon, which is the southern bank of the Tarim river». Now this does not in the least agree with the map, for according to the latter Nukitu-sekin lies north of Nukitu-daban, and Ike-ghaschon east (not west) of Nukitu-sekin. So long as we do not know the meaning of the word *nukitu*, which occurs, as we see, in four compound names distributed over a pretty wide area, and both amongst the mountains and on the plain, we are but fumbling in the dark in attempting to fix the position of the places indicated by these names. Himly translates the name Nukitu-qia-Tarim, which is used to mark the locality where the two roads divide south of Lop-nor, as meaning »abschüssiges Ackerland des Nuki» — *tarim* signifying »arable land», and *qia* »steep»,

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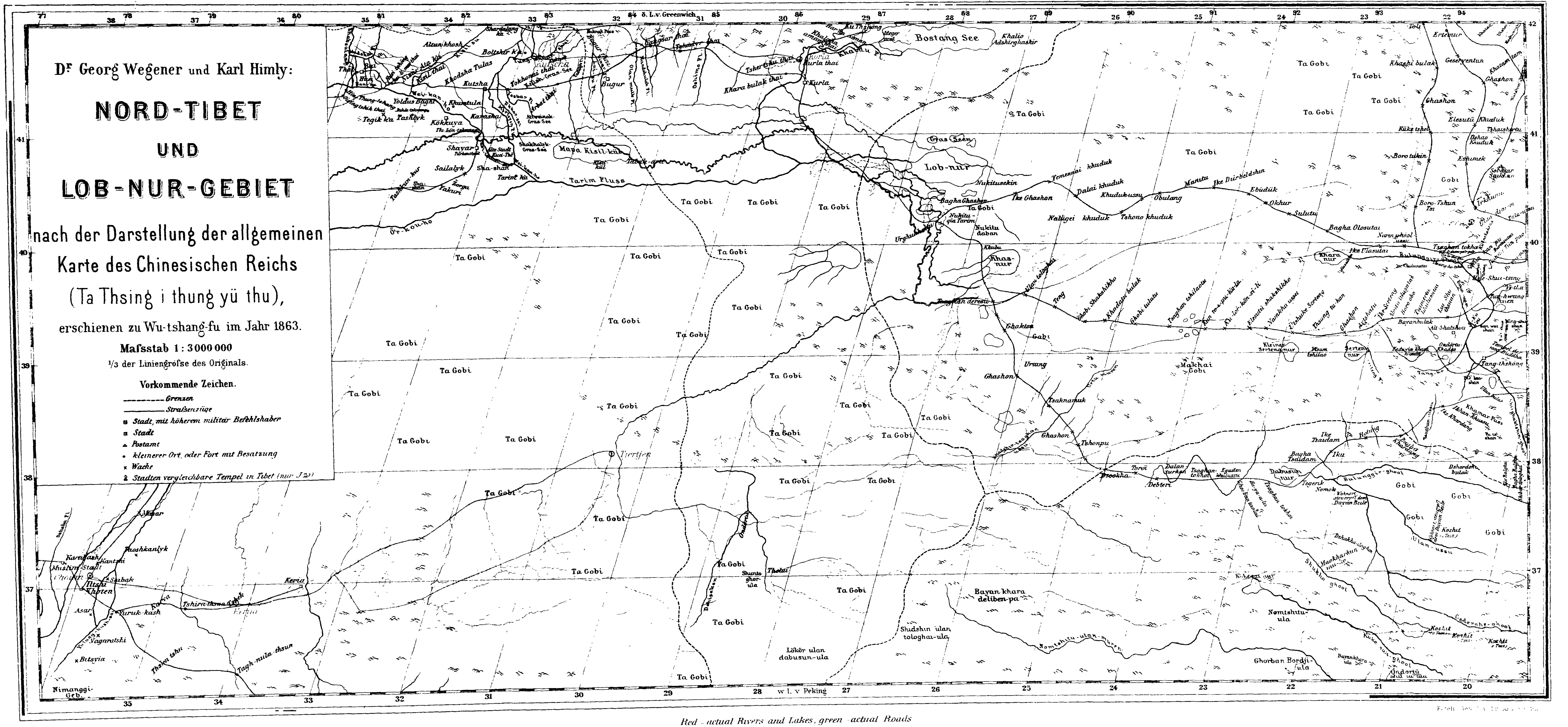
* Morgan, *From Kulja etc.*, Preface p. V.



**Dr. Georg Wegener und Karl Himly:**

# NORD-TIBET
# UND
# LOB-NUR-GEBIET

nach der Darstellung der allgemeinen Karte des Chinesischen Reichs (Ta Thsing i thung yü thu), erschienen zu Wu-tshang-fu im Jahr 1863.

**Maſsstab 1 : 3000000**

1/3 der Liniengröſse des Originals.

Red - actual Rivers and Lakes, green - actual Roads

while *tu* is a Mongolian suffix indicating the adjectival form. If this interpretation is correct, the locality in question must lie somewhere near the mountains, for there are no steep patches of arable land in the lowlands. In fact, the name is placed quite close to the »pass» of Nukitu. Nuki too would be the name of a person, a chief, that being the only way by which we can account for the occurrence of the name both in the mountains and in the lowlands. The relation is one to which we find a parallel in Bedaulet's time, when in this same region there existed the names Jakub Baj-kuduk, Jakub Baj-karaul, Jakub Baj-kurghan, together with several similar place-names. Himly seems to doubt whether *tu* is the Mongolian suffix.* Is it possible that *tu-kia* is the same word that occurs in Takia-tagh, the little mountain-ridge between Kurghan-bulak and Dschahan-saj?** This word I heard pronounced as Tekia, and I was given to understand that it means a »cushion«, because of the resemblance which the mountain bears to such an article. Generally speaking, geographical names beginning with N are extremely few in East Turkestan, as a glance at my alphabetical list in *Peterm. Mitteil.*, Ergänzhft 131, will show at once. Nuki seems to be a person's name, probably a contracted form of two other names, such as Numet and Baki, both still in use in that same locality. For example, Numet Bek was bek of Jurt-tschapghan in 1900 and 1901, and at the same time Nias Baki Bek was chief of Kum-tschapghan. Hence it is easy to conceive the combination Numet Baki; though Numet itself is also a contracted form, and stands for Nur Mohamet. In a precisely similar way, it is easy to see how Nuki may be a contraction for Numet-Baki. *Dake, deki, duke* is a universally current genitive termination occurring in numerous names along the Tarim and its delta, e. g. Niasdake-uj = »the house of Nias«, or as here Nukidake-tarim = »Nuke's river« or »arable land«. The insertion of the *a*, converting the word into Nuki-dakia-tarim may be only a provincialism; just as in the Lop country an *a* is usually added to the title Bek, e. g. Islam Beka, Numet Beka. At all events, if my interpretation is correct, the original Nukidake-tarim has been far less transmogrified in the Chinese transcription than many other words. For my own part, I do not believe that *tarim* does here mean »arable land»; it means »river«, and when the materials for the map were collected an arm issued from the Tarim and flowed to the small southern lakes, an arm into which the entire river gradually transferred itself and so formed the Kara-koschun. In Nukitu-sekin and Nukitu-daban we have on the other hand the Mongolian suffix *tu* (Turki = *li, lik*). According to the analogy already alluded to, the forms should have been Nukitukia-sekin and Nukitukia-daban; although the more familiar forms would be Nuki-bulak and Nuki-davan.

Turning west from Nukitu-daban we come to Nukitu-setsin (= *sekin*, which according to Himly means »spring«). On the Wu-tschang map we find this name at the south-east corner of the Lop-nor, close to the lake. Still farther west we find Nukitu-schan-k'ou; which, according to Himly, means the »mouth» or »valley-opening» of the Nukitu mountain, or mountain-range. These two names, which plainly have to do with mountainous districts, occur nevertheless amongst the lakes, that is to say between Lop-nor and the small lakes south of it. This absurdity is enough to show that the district south of Lop-nor is drawn without any knowledge, and that both the topography and the nomenclature are employed without any definite rules. And it becomes even yet more absurd when we proceed farther from Nukitu-schan-k'ou. We do not read »Farther west you come to Ike-ghaschon», which would mean that we were to proceed *from* Nukitu-schan-k'ou; but what we are told is, »Farther west *from the southern shore of Lop-nor* you come to Ike-ghaschon». How we are to get from Nukitu-schan-k'ou to the southern shore of Lop-nor the Chinese text does not tell us; consequently there is here a lacuna in the itinerary. This makes it perfectly evident, that the cartographical material is derived from two different sources, and that the cartographer has made a desperate attempt to get them to fit, but without success. If we are to proceed west from Nukitu-sekin in order to reach Nukitu-schan-k'ou, then the former must lie *east* of the latter; and if from the southern shore of Lop-nor we are to travel west to reach Ike-ghaschon, then Lop-nor must lie *east* of Ike-ghaschon. On the Wu-tschang map however Ike-ghaschon is shown as lying to the east of Lop-nor. In this case the map is wrong and the text right, for as a matter of fact Lop-nor is placed on the Wu-tschang map $1\frac{1}{2}^{\circ}$ too far to the west, but as near as possible at the right latitude. On the other hand, on the map that accompanies the *Si-yü-schuei-tao-ki*[*] Lop-nor lies a good deal to the east, that is if we compare it with the position of Bostang-nur (Baghrasch-köl). If on the Wu-tschang map we move Lop-nor to the position it actually occupies, according to my explorations, the Chinese text also is right, for then we should have to travel west from the southern shore of the lake in order to reach Ike-ghaschon, and continue thence in the same direction in order to get to Bagha-ghaschon.

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* *Nord-Tibet und Lop-nur Gebiet*, by Wegener and Himly, in *Zeitschrift d. Ges. f. Erdk. zu Berlin*, vol. XXVIII (1893), p. 228.

** See for the position of this mountain Kosloff's account of his journey, p. 100.

I have already remarked, that, as I suspect, the author of the *Si-yü-schuei-tao-ki*, in describing the southern route between Sa-tscheo (or Chara-nor) and Lop-nor has interwoven the descriptions of two different itineraries; that is to say, the first part, and by far the larger part, of his itinerary belongs to a more southerly route, which traverses mountainous country throughout, while the latter part belongs to the northern route, quite a different one from that by which Kosloff travelled from Abdal to Sa-tscheo. Probably some of the cairns of stones which I saw running south-west in the Kuruk-tagh north of Toghrak-kuduk show the direction in which it ran. In order to prove the correctness of my conception, it will be necessary to analyse the three roads which the Wu-tschang map shows as running east from the Lop-nor, and to compare them with the roads which exist now in the same quarter. The one farthest to the south has but little interest for us in this connection. It is shown with extraordinary distinctness on the Chinese map, and there is not the slightest difficulty in identifying it with the road which is still in use along the foot of the southern border-range of Tsajdam. I have myself travelled east along the same road from Ike-tsohan-gol and crossed the Bulungir-gol at the same spot as the road does on the Chinese map. The Dabusun-nur of the map corresponds to my Hollusun-nor, but it has been transposed as far towards the north-

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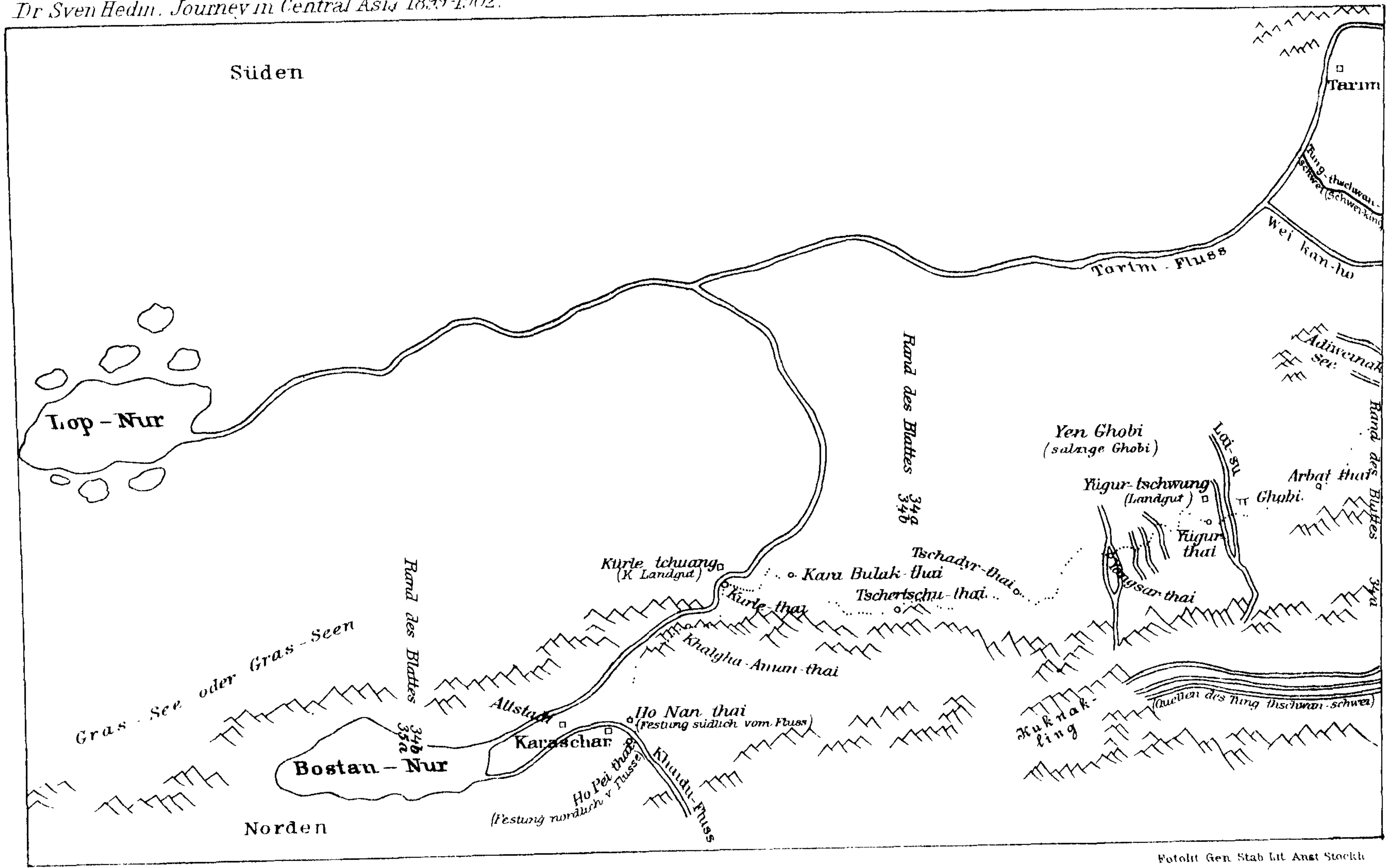
[*] See *Peterm. Mitteil.*, Ergänzhft. No. 131, p. 152.



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west as the Khas-nur, a transposition which consequently affects the entire road together with its names, e. g. Urtu-muren (= Prschevalskij's Utu-muren). The Chinese Tegerik is my Tengelik. Ike-tsohan-gol, with the *aul* (»village») of Tsoha, Prschevalskij's Dsucha, is called on the Chinese map Dsookha. In a similar way, thanks to Prschevalskij's itinerary of 1884, the identifications can be equated all the way from Tsoha to Ghas. For instance, Urtäng and Ghaschon are his Urtin-nor and Gaschun-nor. Hence there cannot exist the slightest doubt as to this route.

But the case is quite different when we turn to the other two routes, which no European has traversed. The more southerly of the two has been already described. It proceeds by way of Bayan-bulak and Khas-nur to the Nukitu-daban etc. It is evident, it was from the Chinese map that this route was laid down on the map of the Russian General Staff, entitled »Map of the Southern Borders of Asiatic Russia», sheet Hami, edited by Major-General Bolscheff and issued in 1899, that is to say at a time when the Wu-tschang map was in vogue. On the whole the course delineated may be taken as correct; although Artschatu (= »the place of the juniper») points to a mountainous region rather than to the lowlands north of Anambaruin-ula. The name Kün-tö-i-pu-k'o-la is regarded by Himly as being equivalent to Güntei-bughora, or the Dark Male Camel. However, as Roborovskij during his travels in 1893—95 passed, on the south of the Anambaruin-ula, the little lake of Chuntei-nor (Man Lake), it is probable that the map of the Russian General Staff is right in its interpretation, namely Kuntei-bulak. The situation too agrees excellently well. Nevertheless I feel pretty certain that the road from Artschatu to Kuntei-bulak does not run amongst the mountains, as it is made to do on the Russian map, but, after crossing over the mountain-chain at Artschatu, it runs between it and the lakes Bulungir-nor and Särtäng-nor, more especially as two lakes, Ütschüke Serteng-nur and Serteng-nur are inserted immediately south of the Chinese route.* The name which succeeds it, Tsaghan-tschilaotu, or the White Stone (Place), lies probably quite close to the mountains; and so too does Chadatu-bulak, or the Cliff Spring. The names Ghobi-tulatu and Ghobi-schakschikho point to a purely desert locality. If the name Ulan-tologhai, or the Red Head, is, as seems likely, a red sandstone or clay-slate mountain, or a spur of the Ak-ato-tagh — and it is in any case situated near this range — I am inclined to believe that the road does not cross the Ak-ato-tagh, as the Russian map makes it do, but keeps south and east of its most southerly extension. This inference is forced upon me by my own experience of the difficult and relatively inaccessible character of these mountains. The road in question has been taken from the map of the Russian General Staff, and incorporated on sheet 62 of *Stieler's Hand-Atlas* (1902), as is evident from the adoption of the misprint Khadamu for Khadatu, which occurs on both maps.

As to the westward continuation of this middle route, I am, as I have already stated, absolutely uncertain, and so too was, it would appear, the Chinese cartographer himself. If, disregarding the known points, we consider simply the distance in *li*, the two routes bear no reasonable proportion to one another. According to Uspenskij the 800 li of the northern route mean the distance as the crow flies, that is disregarding the windings. In reality that route is 600 km. long. By adding up the separate sections of the southern route, we get 1680 li, which, observing the same proportion, ought to be 1260 km., a distance which, if reckoned from Sa-tscheo, would reach all the way to Kerija. But in reality the difference is not so great, for the southern road *via* Ghas (Khas-nur), which starts at Sa-tscheo and ends at the mouth of the Tarim, measures only 700 km.

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* Ever since Prschevalskij's time the Russians have written this incorrectly as Sirtin, instead of Särtäng, the form in which it appears, and correctly, on the Chinese map.

Still this method of calculation is misleading, for the distances between the principal stations are all given. Beginning at Bayan-bulak, which seems to be situated in the vicinity of Sa-tscheo, we have the following stages: 200 + 150 + 730 + 300 = 1380 li to Ulan-tologhai, situated east of Khas-nur. From Ulan-tologhai westwards to the eastern shore of the Khas-nur, thence north to Khu-pu, and then on, after a westward bend to Nukitu-setsin, still north to the southern foot of the Nukitu-daban, and thence still farther west to Nukitu-schan-k'ou — gives altogether a distance of at least 300 li. These last-named points seem therefore to have been situated so close together that the traveller, who furnished the *data* of the itinerary and measured the distances, would appear to have preferred to take the entire route in the lump, instead of specifying the several short intervening sections.

From Sa-tscheo to Ulan-tologhai it is 1380 li or 400 km., and of this fully 300 li lie between Tsaghan-tschilaotu and Ulan-tologhai, corresponding to 87 km. The distance between Ulan-tologhai *via* Ghas to Nukitu-schan-k'ou is precisely the same; but if we measure 87 km. on the map, or say in round numbers 90 km. north from Ulan-tologhai *via* Ghas, we do not get farther than to the latitudinal valley between the Ak-ato-tagh and the Astin-tagh. If however we measure on the Wu-tschang map north from Ulan-tologhai a line equal to the distance between Tsaghan-tschilaotu and the place just named, we are brought to Nukitu-sekin, which, although it is counted to belong to the southern route, is placed on the map to the north of the northern route — a proof that the western parts of these two routes have been confounded together.

Kosloff is no doubt right in suspecting that the Nukitu-davan is identical with the Kurghan-davan, north of which pass we find also a spring (N.-sekin?) and a valley or »mountain mouth» (N.-schan-k'ou?) opening to the north. Nor is the contrary proved by the fact that the actual distance between Ulan-tologhai and this valley-end amounts to 225 km., instead of the 87 km. calculated above. Evidently Nukitu-davan, Nukitu-sekin, and Nukitu-schan-k'ou lie as near together as do Kurghan-davan, Kurghan-bulak, Kurghan-saj, and a possible Kurghan-sajning-aghis, or the Entrance of the Fortress Valley. On the other hand, Nukitu-qia-tarim seems to belong, as I have pointed out above, to the lowlands.

The topographical section in St. Petersburg appears to place greater reliance upon the Chinese map than it deserves, at least in respect of topographical matters. They have also marked on their great map of Asia the third and most northerly of the three routes we are discussing, as well as the roads that proceed north from Sa-tscheo, the lake Toli, and various other features; and from their map both routes and the lake just mentioned have been adopted by *Stielers Hand-atlas*. The interpretation however which the Russian map puts upon the northern route is certainly incorrect. On the Wu-tschang map the road in question runs north of Bulungir-gol and Chara-nor, and Himly's version of the Chinese text begins with the words, »Von K'uku-schakscha am Nordufer des Su-lö-Flusses geht es nach Baghan-olosu-tai; weiter westlich, entsprechend dem Nordufer des (Chara)-nur, heisst es Suluthu, usw.» The Russian map makes the road go south of both river and lake, and then diagonally across the desert south-west towards the Astin-tagh, which it strikes at Kum-bulak. The name Tschono-khuduk of the Wu-tschang map appears therefore on the Russian map (Tschenokhuduk) in close proximity to Kum-bulak; but it ought to be looked for, I am convinced, fully a degree farther north, namely in the Kuruk-tagh. From and beyond Tschono-khuduk the western part of the route disappears entirely, or unites with Littledale's route, with which it has in reality nothing whatever to do. The Russian topographers have clearly supposed that, since, in subjecting the map to the necessary correction, the southern road had to be pushed a degree farther to the south, and the middle route $1^1/_2$ degrees in the same direction, so also the northern road must in the same way be pushed south, so as to run parallel to them; but this is a mistake, because in the Wu-tschang map the eastern part of this road is put half a degree too far to the south, though in the middle it is almost right, while in the west it lies half a degree too far to the north. If now, taking the station Manitu as an axis, we turn the entire map round in such a way that the Chara-nur falls into its proper latitude ($40^1/_2$° N.), the result is to place the Ike-ghaschon on the northern shore of the existing Kara-koschun; and this is far more probably right than the position which is assigned to the road on the Russian map, where the eastern part is incorrect and the western part is wanting.

As we know nothing about the periods at which the different materials for both the map and the text were gathered, we have of course nothing better than guesses to go upon. Himly supposes,* that, as the author of the *Si-yü-schuei-tao-ki* deduces his conclusions from the *Han-schu*, he himself never was at Lop-nor; his own journey really took place about the year 1817. When he says, »So and so happened *now*», »So and so it is *now*», he means, according to Himly, the time in which he himself lived; but unfortunately in his extremely interesting book (*Si-yü-schuei-tao-ki*) it is often difficult to determine what time it is he really is alluding to. I desire however to call special attention to the following passage.

»Der Tarim-Fluss fliesst von dem Gute Kurle 200 li nach Osten und südlich von Karaschar vorbei, dann über 200 li weiter nach Osten südlich vom Bostan-Nur (Baghrasch-köl) und noch weiter östlich in den Lop-nur. — — — Der 'nur' ist von Osten nach Westen über 200 li, von Süden nach Norden über 100 li (gross). Er nimmt im Winter und Sommer weder zu noch ab. Er liegt auf 40° 30' bis 40° 45' N. Br. und 28° 10' bis 29° 10' W. L. Jetzt gibt es nur eine Mündung. Wenn das *Schuei-king-tschu* für einen Süd- und einen Nordfluss je eine besondere Mündung annimmt, so weiss ich nach dem *Han-schu*, welches bei Unterscheidung der beiden Wege deutlich vom südlichen Gebirge redet, ohne dass dort etwas vom Verfolgen je eines südlichen und eines nördlichen Flusses zu sehen wäre, dass, da der eine Wasserlauf auch von Alters war wie jetzt, Li Küns Worte leichthin und ohne Erwägung gesprochen sind. Neben dem grossen 'nur' sind kleine 'nur', die ihn umringen, und zwar im Norden 3 runde ohne Namen, im Süden 4 längliche, von denen einer Ör-kou-hai-thu, einer Bagha-Ghaschon, einer Tha-li-mu-tschi (Tarim-See) heisst, einer keinen Namen hat» — — — —.

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* *Peterm. Mitteil.*, Ergh. 131, p. 163.

Upon this Himly comments as follows: »Die Ausgabe mit Erläuterungen des Li Tao Yüan oder Li Kün stammt aus dem Ende des fünften oder dem Anfang des sechsten Jahrhunderts; wie mir Prof. Hirth mitteilt, bekleidete Li 477—500 ein Amt. Das ursprüngliche *Schuei-king* (Lehrbuch der Gewässer) von Sang Khin aus der Han-Zeit scheint verloren gegangen zu sein; was erhalten ist, soll aus der Zeit der 'drei Reiche' (221—280) sein.» Then he continues: »Der Verfasser, welcher sich meistens auf ältere Werke stützt, hat leider seine eigenen Reisewege im ganzen unberücksichtigt gelassen, oder doch nicht weiter hervorgehoben. Hier schliesst er auf die *eine* Mündung aus dem *Han-schu*. Das *Hou-Han-schu*, die »Geschichte der späteren Han», stammt aus dem 5. Jahrhundert und enthielt zuerst ein *Si-yü-tschuan*, d. h. »Berichte über die Westlande». Nach dem *Si-yü-schuei-tao-ki* (1 küan, S. 25 a) hat Sü-sung selber Ergänzungen und Erläuterungen dazu verfasst.»*

Since then the Chinese author derives his material in part from the 5th century and in part from his own experience (19th century), it is easy to see that, in studying the hydrography of the country in relation to time, we may easily fall into serious error, as I did once or twice in the chapter »Eine chinesische Beschreibung des Lop-nor» in my former scientific work, which I have so frequently quoted above. We have to remember that the author of the *Si-yü-schuei-tao-ki*, who has given us these descriptions of the northern and southern routes from Chara-nor to Lop-nor, criticises a work (*Schuei-king-tschu*) which belongs originally to the 3rd cent., but at the same time relies upon the *Han-schou*, a work of the 5th cent. But although he examined the old writings, as I am doing now, he was not able, as I am, to confirm his conclusions by his own observations. Even his description of Lop-nor and the country around is borrowed, for he says, »Als im Jahre 1759 Ali I-Kung Schalas-Maghos ausrottete und Bayar gefangen nahm, kam er am Lop-nur vorbei und berichtete: am 9. des zweiten Monats kam ich an den Lop-nur. Das Land breitet sich weit aus und ist von dichter Waldung bedeckt etc.»**

The description which follows — it may be read in *Peterm. Mitteil.*, in Himly's translation — is consequently upwards of 60 years older than the date of the Chinese author's own journey; all the same his description belongs to a period when the Tarim had already turned into its present most southerly course, and by Lop-nor he probably means Kara-koschun, although in my former monograph I endeavoured to prove the opposite. On the other hand, I am more convinced than ever that the Lop-nor of both the Wu-tschang map and the map in the *Si-yü-schuei-tao-ki* is identical with the desiccated lake on the northern shore of which I discovered the ruins of Lôu-lan. The text makes it perfectly plain, that between the 3rd cent., when the river had two mouths, and the 5th cent., when it had only one, great hydrographical changes took place in that region. The Chinese author says most distinctly, »Here is only *one* mouth *now*», that is at the beginning of the 19th cent. He does not seem to have understood, or even believed it possible, that any changes could have taken place in the course of sixteen centuries, and evidently is persuaded that the hydrographical conditions remained unchanged from the 5th cent. to about 1817. And yet we know that in 1308 the Dragon Town was destroyed by an inundation, evidently a shifting of the lake. He has no idea that the only mouth which existed in 1817 was altogether different from the one mouth spoken of by the *Han-schu*. This last was the mouth of the Tarim's Kuruk-darja, emptying into the old, northern Lop-nor; the former is the mouth formed about 1740, the present embouchure of the Tarim into the Kara-koschun. As, according to Himly's surmise, the Chinese author did not himself visit the Lop-nor, he confuses the Kara-koschun with the Lop-nor of the old writers; but it is a mistake for which he may readily be pardoned, seeing that the same mistake has also been made by Prschevalskij and Kosloff, notwithstanding that they both visited the region several times.

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* *Peterm. Mitteil.*, Ergänzhft. 131, p. 153.

** *Peterm. Mitteil.*, Ergänzhft. 131, p. 153.

In the same breath in which the Chinese author appeals to the *Han-schu* to prove, that there is only *one* mouth, he also mentions the small lakes, of which three, round in shape, lie north of the big lake of Lop-nor, and four, elongated ones, lie south of the same. It would thus appear that this statement also rests upon the authority of the *Han-schu* of the 5th century. Ali I-Kung does not mention these seven small lakes, but on the other hand he does mention a very small lake on the southern shore of which an ocean of sand extends, while south of that there are plenteous steppe and kamisch-fields on the northern shore of Lop-nor (i. e. Kara-koschun or Utschu-köl). One proof that the circumstances in 1759 were different from what they are now is to be seen in the fact, that there are no such thick belts of vegetation on the northern shore of the Kara-koschun. Nevertheless, as I shall attempt to prove lower down, it seems as though the position assigned to Lop-nor on the map belongs to a far earlier time than that of the small lakes.

These seven small lakes are all marked on the Wu-tschang map, on the map in the *Si-yü-schuei-tao-ki*, and on a third map, the I-thung-yü-thu map, mentioned by Himly. As I have already pointed out, Lop-nor is placed on the first-named $1^1/_2$° too far to the west, consequently the seven lakes too share in the displacement. The latitude is 40°30′ to 40°45′. If the four lakes to the south of the Lop-nor really did occupy the positions relatively to the big lake which is assigned to them on the map, the one farthest south, Ör-kou-hai-thu, ought to lie about 40 km. from its southern shore. From this it follows that the Lop-nor of the Wu-tschang map *cannot* be identical with the Kara-koschun, for at the distance of only 17 km. south of the shore of the last-named, that is to say at Dungluk, the altitude is already more than 200 m. above the level of the Kara-koschun itself, and at 40 km. distance it is double the altitude of the Kara-koschun. Accordingly the Lop-nor of the Chinese map lies at all events north of the Kara-koschun, and as its latitude agrees with the latitude of the depression which I discovered immediately south of Lôu-lan, it is consequently this last which is represented on the map in question.

Turning now to the seven small lakes, I observe that the three northern ones, which bear the common name of Thsao-hu, or the Grass Lake, are probably identical with the extreme northern parts of the Lop-nor, the region immediately south of the Kuruk-tagh where I discovered the survivals of the old kamisch-fields. They were no doubt directly connected with the Lop-nor, into which the Kuruk-darja (= Tarim + Kontsche-darja) conveyed its waters. The fact of the map showing them as detached signifies nothing, for their connections with the main lake may easily have been completely hidden by the kamisch. How Lôu-lan was situated with regard to these three lake-divisions it would be impossible to say, for this town does not appear on the map. Further, we are distinctly told in the text that, south of the Baghrasch-köl, the Tarim river flowed to the east, and that, still farther in the same direction, it emptied into the Lop-nor. If, on the Wu-tschang map, we take one step farther south, we come to the four small lakes, three of which have names, namely Urghu-khoitu (the Eastern), Bagha-ghaschon (the Little Salt Lake), and the Tarim Lake; the smallest lake, the one farthest west, bears no name. I have already stated that these four lakes occupy the same position on the Wu-tschang map that they occupy on the *Si-yü-schuei-tao-ki* map. But the text of the latter is far from being in agreement with the map. It is my firm conviction that here again the map is based upon materials collected at different periods. In order to prove this however, I must once more quote Himly, who says:

»Der Verfasser (von *Si-yü-schuei-tao-ki*) Sü Sung Sing Po, welcher sich 1817 selber in Ili aufgehalten hatte, wurde dadurch veranlasst, 1824 das vorliegende Werk herauszugeben. Unähnlich den meisten Beschreibungen der Kreise, Bezirke and Statthalterschaften des eigentlichen China's, geht dasselbe von den Flüssen aus und beschreibt im Anschluss daran die an ihnen gelegenen Ortschaften, nebenbei aber auch die weitere Umgebung unter Rücksichtnahme auf die frühere Geschichte des Landes. Von den fünf Heften umfassen die ersten beiden das Gebiet des Lop-Nur und des Tarim-Flusses, also Ost-Turkistan, das dritte diejenigen des Khara-Nur», etc. — — — »Zu jeder Abteilung gehört eine Karte.»* Then he continues: — »Des Verfassers Aufzeichnungen scheinen zu sehr verschiedenen Zeiten gemacht zu sein, und wie das dritte Heft auf die beiden ersten folgt, die vom Lop-Nur und seinen Zuflüssen handeln, so wird der Verfasser zur Zeit, wo er über den Khara-nur schrieb, besser Bescheid gewusst haben. Der Bagha-ghaschon ist offenbar einer der vier kleinen südlichen Seen, ghaschon (»bitter») war er wohl, ehe der Tarim-Fluss hineinfloss. Nun möchte der Tarim-See aber wohl auch dahin zu verstehen sein, dass der Tarim-Fluss seinen Lauf dahin genommen hat.»**

And just as, according to Himly, the cartographical notes were written down at different periods, so also the sources would appear to belong to different epochs. If the water of the Bagha-ghaschon was once salt, it must have turned fresh after the Tarim flowed into it, for in all probability this river continued towards the east-north-east as far as the Ike-ghaschon, a salt-lake of which nothing except the name appears on the map. In this circumstance again we can discern the implication of a hydrographical change. In agreement with Himly, I consider it likely that *koschun* in Kara-koschun is the same word as the Mongolian *ghaschun* (= »bitter»). Ghaschun-nor is a very common name in all Mongolian countries. The Ike-ghaschon and the Bagha-ghaschon, the Great and the Little Salt Lake respectively, are therefore two small lakes lying, according to the Wu-tschang map, the former on the east, the latter on the south, of the southern shore of Lop-nor. But the text tells us, that »on the west of the southern shore of Lop-nor you come to Ike-ghaschon».

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* Karl Himly, *Ein chinesisches Werk über das westliche Inner-Asien*, p. 2.
** *Peterm. Mitteil.*, Erganzhft. 131, p. 145.

The lake region south of Lop-nor is distorted on the map, and the road from Sa-tscheo is incorrectly drawn in relation to the lakes, although the error is less than in the case of the two southern roads. Nevertheless I believe I have discovered the key to the puzzle. You have only to endeavour to interpret these Chinese records in immediate connection with the actual circumstances on the spot, and the matter becomes at once tolerably clear, and as I am the only traveller who has visited the region in question, the interpretation is naturally easier for me than for anybody else. But first let us examine the probable course of the northern route, as it is described in the third part of the *Si-yü-schuei-tao-ki*.

The Wu-tschang map makes it run north of the Bulungir-gol towards the west-north-west. The same map puts Sulutu about 50 km. north-west of the Chara-nur; but this does not agree with the text, which says that it lies near the northern shore of the lake. The Chinese author goes on to explain that Sulutu means in Turki »Reed hut». The following names: Okhur, Ebüdük, Ike Dürbeldschin, Manitu, and Obulang belong, I feel certain, to the mountainous regions south of the Kuruk-tagh. And for this opinion I am able to adduce three reasons: (1) In that locality I crossed over a road running east and west, and marked by cairns of stones; this road, there can be no doubt, formerly ran to the ancient Lop-nor, the mountain route being preferred because of the greater hardness of the surface, and possibly also because of the existence of one or more springs; (2) *khuduk*, the word for a »well», does not occur, and it is only in the lowlands, not in the mountains, that wells are ever dug; (3) Ike Dürbeldschin, the Great Four-square, points to the shape of a valley, and Manitu, the »Mani Place», is a cairn built up of stone slabs, with the Buddhist formula *On mane padme hum* engraved on them. Cairns of this character, called also *obo*, are generally spoken of simply as *mani* or *mane*. Now a cairn of this description can hardly have been set up in any except a mountainous region, where there is an abundance of stone.* Himly translates Ma-ni-thu as meaning Place of the Mani Banner.

The name that follows next, Khuduk-ussu, or the Well Water, suggests that the road has again left the mountains; and the same inference admits of being drawn from Tschono-khuduk (the Wolf Well), Nalügei-khuduk, and Dalai-khuduk. The road between the two last-mentioned wells is said to run north of Nukitu-ling, although in reality it ought to be north-north-east or north-east of that pass, which I have already identified with Kurghan-davan. Unfortunately we are not told how far north of the pass the road ran, any more than we have been previously told how far the Tarim flows towards the east, south of the Bostan-nor. The name Dalai-khuduk is interesting, for *dalai*, a Mongolian word, means »sea», consequently, according to Himly, »great». But in this case »sea» is the better meaning, since, as the names of the following stations clearly prove, the road traversed the basin in which the Lop-nor was situated, and that lake was called by the

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* One such *obo* or *mane* is pictured on p. 507 of vol. I of my book *Central Asia and Tibet*, as also on p. 1077 of vol. II of *Through Asia*. — The Mussulmans always call these high sacrificial places *mane*; they are frequently hung about with small streamers.

Chinese »sea» in various compound forms. The Great Well is therefore an improbable name; it ought to be Deep Well, or something similar.

The text then goes on to say, that the road continues »to Temen-ghaschon south of Lop-nor». But on the Wu-tschang map, on which the western half of the road, as we have seen, must be shifted a little to the south, we have Temmenai-khuduk. Upon this Himly makes the following comment, »Mongolian *temen* = »camel»; *noir* = »sleep»?; *khuduk* = »well»; that is to say, the Well of the Camel's Sleep, or the Sleeping Camel's Well.» Against this interpretation there is no objection to make, for that is precisely the region in which wild-camel are found, and it is easy to suppose that one was on some occasion seen near a well. But the text appears to me to give much the likelier version when it goes on to add, »towards the west to Temen-ghaschon south of Lop-nor, and farther southwards to Bagha-ghaschon». Ike-ghaschon is not mentioned at all. Why is that? Simply because Temmenai-khuduk and Ike-ghaschon are one and the same, namely Temen-ghaschon, a salt lake on the shore of which there possibly was also a well, and this has given rise to the confusion.* The transcription of Temmenai-khuduk adopted by the Chinese map is, according to Himly, Thö-mön-nai-hu-tu-k'ö. By analogy therefore the Temen-ghaschon of the text ought properly to be Tömön-ghaschon or Tömön-koschun; the words *tömön*, *tömen*, *tömenki* mean in Turki the »lower», the »nether».** Hence it is some Lower Lake which we have to consider; and it was clearly called by the Mongols Ike-ghaschon, or the Big Salt Lake, by way of contrast to Bagha-ghaschon. My survey proved that Kara-koschun, which in my opinion is certainly identical with the Ike-ghaschon and Temen-ghaschon, lay south of the ancient Lop-nor. Consequently in this case the text is right, but the map is wrong, that is to say with regard to the road and the small lakes.

In the third part of the Chinese document we are told, that the Bagha-ghaschon lies south of the Tömen-ghaschon, but in the parts dealing with the Lop-nor that the Ike-ghaschon lies west of the southern shore of the Lop-nor, and that the Bagha-ghaschon lies west of the Ike-ghaschon. This contradiction is not however so serious as several others which have been pointed out above, for at the present day the western parts of the Kara-koschun lie south-west of at all events the eastern part of the old Lop-nor, and Chinese itineraries use scarcely any others except the four principal quarters of the compass, so that in this particular the writer may have been in doubt whether he should say south or west.

I have already stated (p. 286 and 287) that in my opinion the author of the itinerary, in describing the southern route, *via* Khas-nur, has been guilty of interchanging two routes, or at all events of an anachronism, in that, after bringing us to Nukitu-schan-k'ou, he goes on to say that, when we are on the southern shore of Lop-nor, we have the Ike-ghaschon to the west. Lop-nor and Ike-ghaschon both belong to the northern route, which is more distinct and easy to follow. It is true, the two routes may conceivably have united at Ike-ghaschon, so that the last portion, west from that point, was common to the two, as is indeed the case at the present time, when

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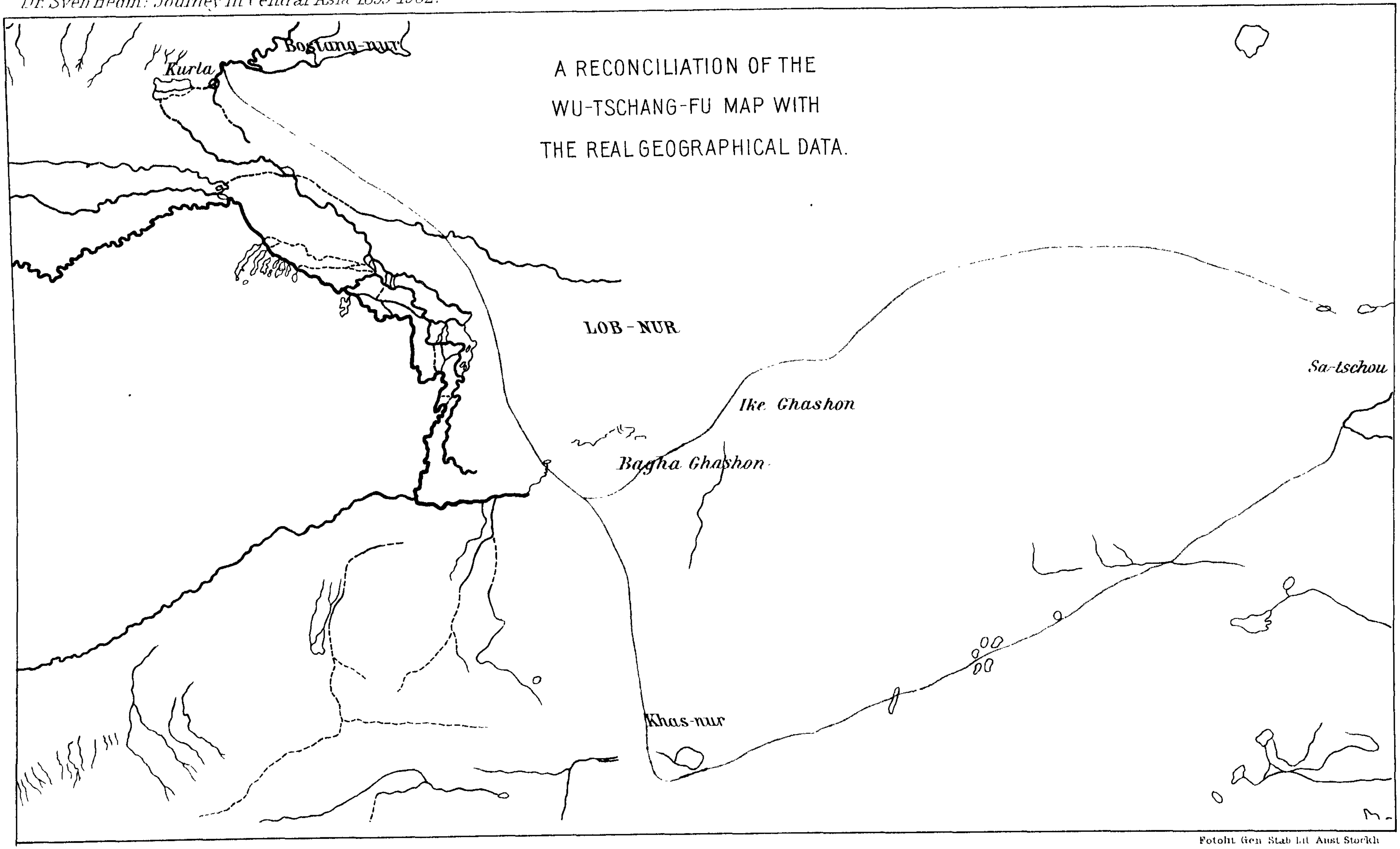
* When travellers encamp beside a salt lake, they always dig a well near the shore, for the water which comes into it is in general somewhat less salt than that in the lake.

** Compare the list of names in *Peterm. Mitteil.*, Erganzhft. 131.

# A RECONCILIATION OF THE WU-TSCHANG-FU MAP WITH THE REAL GEOGRAPHICAL DATA.



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——— Old roads

Roads of the present time

the two roads from Sa-tscheo meet at Jol-arelisch; but the map shows the two routes in question meeting on the south-west shore of the lake of Urghu-khoitu and at Nukitu-qia-tarim, and both Ike-ghaschon and Bagha-ghaschon lie a long way east of that point. In all probability what the text ought to have told us is, that from Nukitu-schan-k'ou the road proceeded north-west to Nukitu-qia-tarim, as it is made to do on the map.

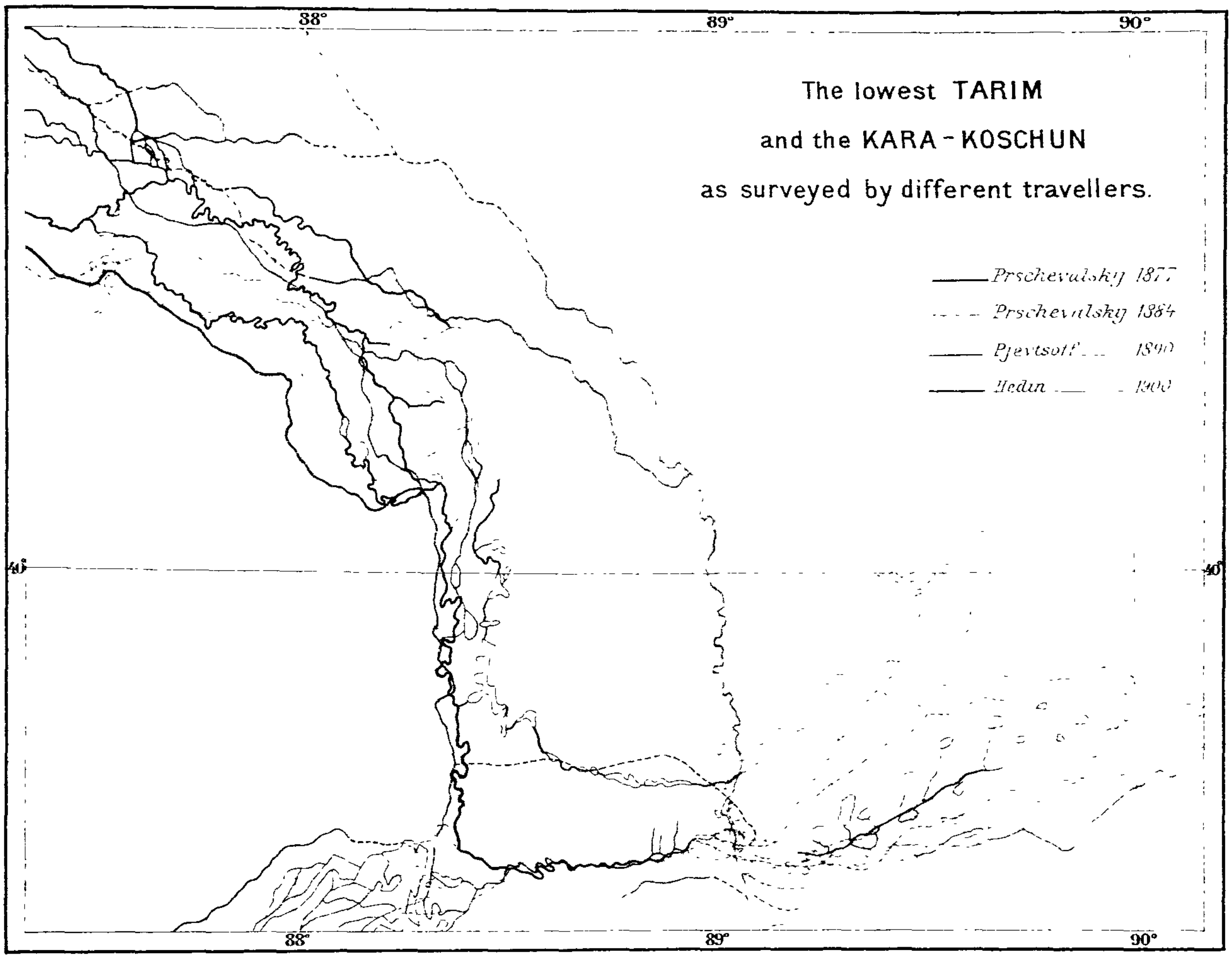
Having advanced so far in the interpretation of the text and the map, we have no difficulty in imagining the rest. Had the Chinese author visited the region himself, he would never have entered the old Lop-nor on his map at all, for of that ancient lake there certainly survived at the time he wrote nothing more than traces, nor would he have put in the Kuruk-darja either. These he has therefore borrowed from one of the old documents for which he entertained such a profound respect, and in fixing their position he was guided by some ancient map, on which the lake occupied its former site in lat. $40\frac{1}{2}^\circ$ N. On the accompanying sketch-map (*vide* pl. 34). I have attempted to reconcile the data of the Chinese map with the conceptions which we Europeans, with our better and more accurate methods of topographical determination, have formed of the Lop-nor region. Let us take a general glance at the Wu-tschang map. The Bostang-nor or Baghrasch-köl is the lake which lies nearest to its proper latitude and longitude. Along the road that proceeds west from that lake we find Korla, Tschadir, Bugur, Kutschar, and Baj, all a little too far to the south and west, though Korla lies in approximately its proper longitude; but the error increases the farther we go west, until in the case of Baj the displacement is three times as great as for Tschadir. There is an almost equivalent error for the towns on the southern East Turkestan route. Kerija, whilst put at almost the proper latitude, has been shifted a little less than $\frac{1}{3}^\circ$ too far to the west. With the latitude of Chotan there is not much fault to find, but its longitude is one degree too far to the west, an error exactly equal to that of Baj.

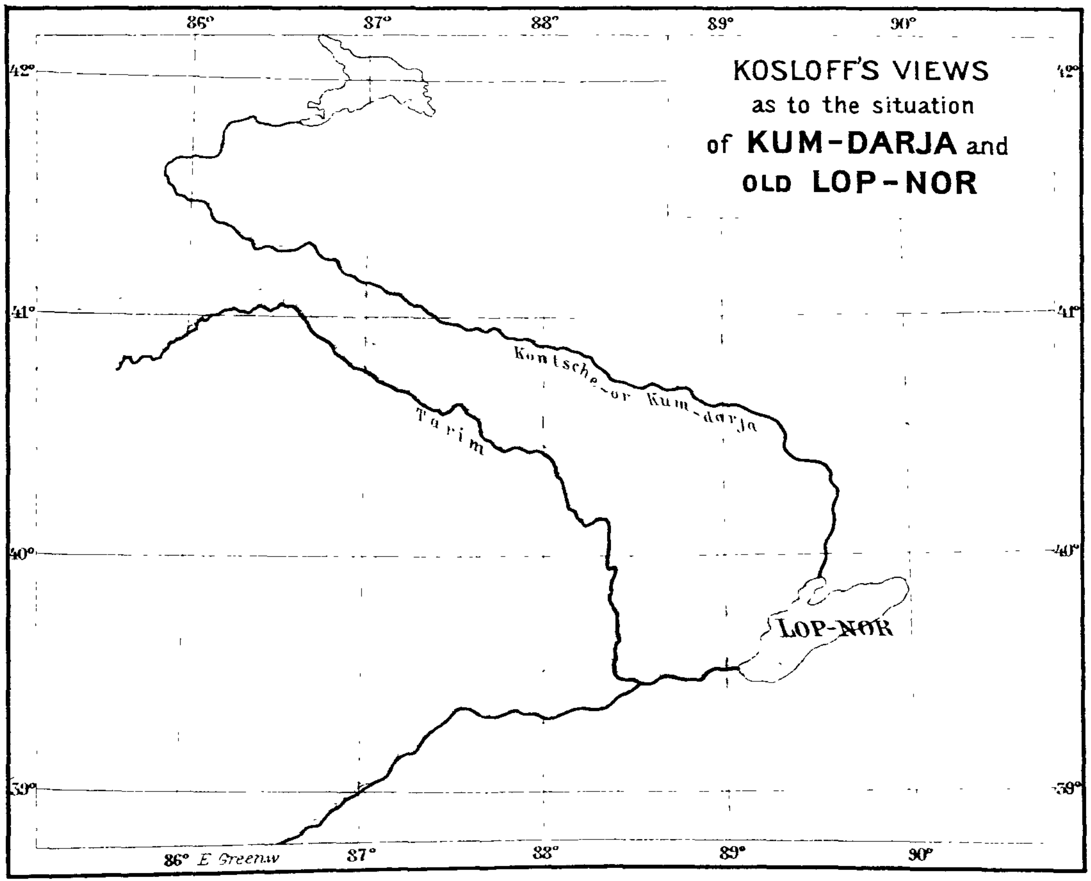
The Mapa-kisil-kül, which still haunts our maps under the names of Baba-köl and Sarik-kamisch, has probably experienced a displacement to the south similar to that of the towns which lie to the north of it. Nevertheless its position with regard to the river Tarim is plausible. Presumably this marsh has now disappeared, no matter whether it was formed by a river from the Tien-schan or was only one of the numerous marginal lakes along the Tarim. As for the Tarim itself, it would appear to be placed, on the whole, a little too far to the south. Here again the error of latitude would appear to increase from east to west, the river being drawn in the west fully $\frac{1}{2}^\circ$ too far to the south; whereas on long. $85\frac{1}{2}^\circ$ it is only $\frac{1}{12}^\circ$ out in point of latitude. South of Bostang-nor the two rivers intersect one another, and farther east the Tarim of the Wu-tschang map lies north of the existing Tarim. Nevertheless it is very possible, nay probable, that on the Wu-tschang map the western part of the Tarim, and indeed in general its course throughout, is perfectly correctly drawn, especially as it may be assumed, that the material from which the river was drawn was, like that for the Lop-nor, of ancient date. To me after mapping the whole of the Tarim, as I have done, and ascertaining that not a single year passes without changes in the situation of the river-bed at various points, it would have appeared much more wonderful had the Tarim on the Wu-tschang map shown any closer agreement than what it actually does show with my own map. On the contrary I have endeavoured to prove that for thousands of years the river has been levelling down its basin, and making its accompanying belts of vegetation precisely as broad as they are here. In the description of the river Tarim given in the first volume of the present work, we had a whole series of river-beds which successively dried up one after the other, and all lying south of the existing river-bed. When travelling from Kerija to Schah-jar I also crossed over an Atschik-darja lying south of the Tarim of the Wu-tschang map. The Chinese delineation of the river thus falls in point of latitude between the present Tarim and its dried up arms, and hence may be regarded as being perfectly correct.

The two positions of the Baghrasch-köl are, we have found, fairly in accord the one with the other. From that focus of greatest exactitude the errors appear to increase outwards in every direction. At Lop-nor the error in respect of latitude is extremely slight, only a few minutes, and as for the Kontsche-darja, it is not at all unlikely that the river did have then the course which is assigned to it on the map, except that its southern part is placed, like the Lop-nor, too far to the west, as well as at Korla, where the longitude is otherwise correct, too far to the south. Lop-nor is put $1\,^{3}/_{4}^{\circ}$ too far to the west. That however is a venial error in a Chinese cartographer, seeing that even such an experienced traveller as Prschevalskij obtained such different longitudes as 89°35′ in the year 1877 and 88°59.8′ in 1884—85, the difference being due to the adoption of a more reliable method on the second occasion. The different positions he assigns to the lake are shown on plate 35. It is indeed matter for congratulation that the Chinese cartographer's errors are not more than three times as great as those of Prschevalskij.

We have found the greatest errors in latitude in the region immediately south of Lop-nor. While, generally speaking, the northern portion of the map, with the exception of the Baghrasch-köl and the Lop-nor, is carried too far to the south, the region of Kara-koschun, Khas-nur, and Tsajdam are pushed too far to the north. The consequence is that along the line where the two sections meet, the map is distorted. We are, it is true, told that four elongated lakes lie south of Lop-nor, but we are not told at what distance. Since the distance between the southern shore of Lop-nor and the northern shore of Khas-nur amounts to only one-quarter of the real distance, it is obvious that the lakes, and mountain-ranges, and roads which exist between these two lakes are much too crowded together for them all to find room on the map. If now Lop-nor is transposed $1\,^{3}/_{4}^{\circ}$ to the east and Khas-nur $1\,^{3}/_{4}^{\circ}$ to the south-east, so that both lakes occupy their true positions, then naturally the geographical features which come between them will experience a similar transposition, the direction being a resultant line between east and south-east, i. e. east-south-east, and the distance arranged proportionally to the transposition of the Khas-nur. The result is that the four small lakes, together with the fifth, the Ike-ghaschon, the name of which only is given, come to occupy precisely that part of the basin in which we now find the Kara-koschun. Consequently this lake is identical with the Ike-ghaschon and Bagha-ghaschon of the Chinese map; and this is what I wanted to prove (see Pl. 34).

At the same time it is quite clear that the cartographical material is derived from different epochs. The positions of the small lakes relatively to one another is





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probably somewhat incorrect; still that is of little consequence. Urghu-khoito, or the Eastern, lies rather in the west; but the lakes altogether extend from west-south-west to east-north-east precisely as the Kara-koschun does, and the intervals between them were no doubt filled with reeds, just as those portions of the Kara-koschun which stretch between its open expanses are at the present day.

But the instructive fact is that the Tarim emptied itself into these same small lakes. One of them is called the Tarim Lake; and we also have on the map the name Nukitu-qia-tarim. The text says, »Baghan-ghaschon, which is the southern bank of the Tarim River» — a perfectly unassailable indication that the river emptied itself into that lake.

On the other hand, the map does not show any river-arm whatever emptying into any of these lakes. The Tarim empties itself entire into the Lop-nor. Is it conceivable that these small lakes were connected with the Lop-nor, and that the connecting arms were only hidden in the kamisch? That is very likely to have been the case at the time the Lop-nor was flitting towards the south. But it is far more likely, that the delineation of the Tarim and the Lop-nor are copied from a far older source, dating from the time which has left in the desert at the present day such clear indications as the Kuruk-darja, with its forests, the Lop-nor basin, and the ruins of Lôu-lan.

The information given to the author of the *Si-yü-schuei-tao-ki*, with regard to the position of the Ike-ghaschon and Bagha-ghaschon, that they lay south of the Lop-nor (the lake which even *then* had been dried up for hundreds of years) is derived from his own age, for he must certainly have come in contact with many merchants and officials who had travelled between Sa-tscheo and the country of Lop. Notwithstanding this information, that the Tarim emptied itself into the small southern lakes, the compiler of the Wu-tschang map has not dared to depart from the statements in the old sources, that this river emptied itself into the Lop-nor; accordingly on his map we have these small lakes depicted as isolated and detached, deriving their water from God knows where.

Richthofen's conclusion, »That the Tarim formerly had only one easterly course to the true great Lop-nor, but later, at the place where it is now joined by the Ugen-darja, it threw off a branch to the south-east, which became the main river», describes exactly the actual course of events; but his addition, »that this branch discharged into the once isolated Khas-Lake, enlarged it, and made it the chief reservoir», is incorrect, for the hydrographical changes to which he is alluding took place in the small lakes lying south and south-west of the Lop-nor.

On the Wu-tschang map we have, south-west of Lop-nor, a lake which resembles the Khas-nur (Khas-omo) almost down to the minutest details. The lake in question bears no name. Richthofen says with regard to it: »as none of the earlier maps have it, and as it corresponds in almost every respect to Khas-omo, it is probable that, owing to some error, the latter lake has been delineated twice over. Though I know of no other instance of the kind, I conjectured this to have been an error even before Prschevalskij's journey, inserting both lakes, however reluctantly, on the map accompanying my work on China.»*

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* *From Kulja* etc., p. 147.

For my own part I do not believe that the presence of this lake on the map is due to a duplication of the kind suggested, but that it, like the other lakes in the locality, actually existed, and had existed from time immemorial, just as well as it existed in the beginning of the 18th century, and exists to-day in the beginning of the 20th. In common with the entire region south of Lop-nor, it is placed too far to the north; to find its true position it must be transposed, like the Khas-nur, to the south-east, though to barely half the distance that this latter lake has to go. That would bring it into the position where the Kara-buran now is. It is indeed true, that this lake has shrunk immensely since 1877, and that not even the proximity of the Tarim, and its passage through it, are able to maintain its vitality. But we have also seen, that the Tarim is on the point of separating itself altogether from the lake by embanking itself within fresh ramparts or banks. The Kara-buran would disappear entirely were it not for the Tschertschen-darja. In 1899, relying upon Roborovskij's statement, that there was an old bed of the Tschertschen-darja in the desert about 65 versts to the north of the existing bed, I formed a very different opinion with regard to this stream. But after having myself sought in vain for the old river-bed in question, and having therefore no reason to believe in its existence, I must entirely change my former opinion. I believe, then, that the Tschertschen-darja, setting aside the usual slight deviations within very narrow limits, has on the whole always had the same position that it now occupies. It has always issued into a lake situated in the vicinity of the Kara-buran, which possibly has also from time to time shifted its position, as the Lop-nor has done, though to a far less extent. If I am right in my supposition, this part of the map dates from a time antecedent to the year 1740, for it does not show the Tarim issuing into the lake. This must therefore have been of very small extent, and would only contain water after the spring flood came down. The presence of the conventional sign for a mountain placed on its eastern shore means nothing, for similar marks are put in parts of the desert where not the smallest chip of a rock can be discovered. Four watercourses, corresponding to the deltaic arms of the Tschertschen-darja, enter the lake from the west and the south. The man who first sketched this lake can never have penetrated farther to the south-west, and consequently had no idea that those four streams were the arms of a large river delta. Hence between the Lop-nor region and Kerija the map shows an extensive patch of white. On the other hand, Öndörtü and Dschiseken cannot be anything else but the head-streams of the Tschertschen-darja, and, remarkably enough, they are mapped in the right positions. Hence, while the map shows us the beginning and termination of the Tschertschen-darja, all the middle part of the river is wanting. Accordingly the following statement of Kosloff is only in part correct: »It is clear that the Kara-buran, equally with the Tschertschen-darja, which empties into it, and which is about 600 versts long, was not known to the compilers of the Chinese map; nor did they know anything about the oases of Tschertschen and Nija either.»

The resemblance between the terminal lake of the Tschertschen-darja and the Khas-nur is only accidental. The latter lake also receives from the south-west three short affluents; and at the present day several small torrents, fed by springs, enter this lake from the south-west, as I shall describe in vol. III.

The foregoing investigation will also show the untenability of Kosloff's statement: »Since the Lop-nor lies, according to the description quoted (from the *Si-yü-schuei-tao-ki*) and according to the (Wu-tschang) map, at the northern foot of the mountain Nutsitu, the Kara-koschun-kul is therefore as an actual fact nothing more nor less than the historical Lop-nor, as indeed Prschevalskij recognised.»

Not only is this conclusion illogical, but, when compared with the text and the map, it is inaccurate. For, taking the map first, what it shows as lying at the northern foot of the Nutsitu is *not* the Lop-nor, but the series of lakes Urghu-khoitu, Tarim-nor, Bagha-ghaschon, and Ike-ghaschon or Tömen-ghaschon, corresponding to the Kara-koschun, the lake which Prschevalskij, through an easily explicable mistake, identified with the Lop-nor. Then as regards the text, when describing the northern route, it tells us that the Ike-ghaschon lies south of the Lop-nor and the Bagha-ghaschon south (i. e. south-west) of the Ike-ghaschon. With regard to the Kara-koschun, we have proved by means of the local traditions, that it was formed about the year 1740, at a time when the historical Lop-nor had long disappeared. Prschevalskij did *not* therefore discover the historical Lop-nor, but the newer creation, the Kara-koschun; though this does not in the slightest degree diminish the value of the discovery he did make, or at all dim the lustre of the fame which will make his name immortal in the history of Asiatic exploration and travel. It may be regarded as a fortunate circumstance, that he himself clung so tenaciously to the conviction that he had discovered the Lop-nor, for otherwise this discussion would never have taken place, nor would the problem be now solved, and definitively settled and done with.

# CHAPTER XXI.

## AUTHOR'S REPLY TO KOSLOFF'S CRITICISMS. KRAPOTKIN, GRENARD.

I now pass to the second section of the chapter in Kosloff's work which is written to controvert Richthofen and myself; but with this I shall be able to deal briefly, because it does not contain very much that is new, and but little that has to do with the real Lop-nor question. Still there are one or two statements that require an answer. The section opens thus: »Setting aside the arguments which Sven Hedin bases upon the Chinese map, which, as we have seen, it is impossible to make use of for determining the geographical coordinates of any of the places entered on it, I now proceed to examine the other proofs which Sven Hedin has brought forward to support the hypothesis, that the lakes which he discovered must be surviving portions of the ancient Lop-nor.»

In a note to the word »discovered» he adds, »or rather described, for these lakes are mentioned by M. V. Pjevtsoff in *Trudij Tibetskoj Ekspeditsij*, vol. I, p. 317.» Upon turning to the passage referred to, we find, »In the year 1880 the Kontsche-darja, 35 versts above its mouth, broke away to the south-east, and, entering a deep valley, turned towards the south, confining itself to a *single* channel. On its way through the valley in question the river formed four deep lakes, Tschiminlik, Sogot, Tal-kejtschin, and Tokkum-kul, from 5 to 7 versts long and from 2 to 3 versts wide, their banks being overgrown with tall reeds.» The position assigned to these four lakes on Pjevtsoff's map agrees fairly well with the lakes which I discovered. But as we have seen in the first volume of this work, their names are incorrect, for the largest lakes in the eastern waterway are called the Avullu-köl, Kara-köl, Tajek-köl, Arka-köl, and Sadak-köl, with which is connected a series of smaller lakes; whereas Sogot, Tal-kitschin, and Tokum-köl, have nothing whatever to do with the lakes I discovered, for they all lie quite close to the bank of the Tarim. According to his itinerary, Pjevtsoff visited neither the one nor the other of these series of lakes, for he travelled along the *right* bank of the river. He would seem therefore to have confused the two chains of lakes, of the existence of which he was told by the natives. As a matter of fact, be had not the faintest inkling of the existence of the large lakes which I *discovered* in 1896.

Passing over Kosloff's long description of the migration of the Kontsche-darja towards the south-west, I will merely cite here the following passage: »According to the natives, some 9 to 15 years ago a breach occurred almost exactly midway in the Kuntschekisch-tarim, where its banks were low, and possessed of but little power of resistance; the water poured out and went back to the Ilek, filled the sandy, saline basin of the Tschivilik, revivified the lake-like, dried-up valley of the Ilek, which the natives began to call the Avullu-kul, Kara-kul, Sogot (Arka-kul), and so on.» But in supposing that these names originated at that late date Kosloff is making a mistake. As early as 1722 we find the names Kara-kul, Sadak-tu, and Kara-khodscho, no doubt the names of Turkish tribes dwelling at Lop-nor, but since that time, or even then, they were also the names of lakes. In 1876—77 Prschevalskij divided the people into Kara-kultsi and Kara-kurtschintsi, and adds the explanatory note, »not far from this village (Ak-tarma), on the opposite side of the Tarim, lies Lake Kara-kul, which has given its name to the inhabitants of the Tarim valley.»

Kosloff has followed Pjevtsoff in confounding the eastern waterway with the inner waterway which belongs to the immediate neighbourhood of the Tarim. His lake Sogot, which is essentially apocryphic, i. e. a pure marginal lake (see vol I fig. 171), is at any rate not identical with the Arka-köl. He says that »the shores of the Sogot are inhabited all the year round;» but it is only sometimes in spring that the shores of Arka-köl are visited by fishermen and collectors of wild-ducks' eggs, but it is quite an exception if they remain longer than one night. My map of this region will show that Kosloff's Sogot is neither the actual Sogot, which has been dry for several years, nor the Arka-köl, which lies somewhat farther east, but is identical with the Tosghak-tschantschdi. He states that from the Sogot in question there issues an arm Ilek, which empties itself into the Tarim 20 versts below Ajrilghan; perhaps he means by this the Almontschuk-kok-ala. The real Ilek, on the other hand, which issues from the Arka-köl, joins the Tarim at Schirge-tschapghan, almost 50 versts below Ajrilghan. Owing to the misleading information which Kosloff has given, the lower part of the eastern waterway on the map of the Russian General Staff (sheet Hami, 1899) is so confused that it is like a species of bastard between my lake route and the marginal lakes on the east side of the Tarim. And yet I had exhibited to the Imperial Russian Geographical Society a large map of the entire region, and in my book which came out at London in 1898, and at St. Petersburg in 1899, I gave a description of my journey along the lakes in question. But on the Russian map the lowest part of the Ilek, which joins the Tarim at Schirge-tschapghan, is not plotted at all, nor even so much as indicated by name. The compilers of the map have preferred the hearsay evidence of Pjevtsoff and Kosloff, given to them by the natives (for neither of them was ever there himself) to that of the map which I made on the spot.

When describing the Kuruk-darja, I alluded to Kosloff's view with regard to the migration of the Kontsche-darja. According to him it was the Kontsche-darja only which flowed in the now dry bed, whereas the Tarim continued in the same bed that it now follows down to Lop-nor (i e. Kara-koschun). »In the course of time the river inclined more and more towards the south, until eventually it formed an angle of 40° to 45° with its original position, and so assumed the course it now follows, and in that way united itself with the Tarim. At all events in that far distant time the Kontsche-darja was directed, just as it is now, towards the lowest part of the desert through which it flows, namely the Lop-nor (of course still to be identified with the Kara-koschun). In other words, Kosloff believes that the Kontsche-darja, after flowing east through the bed of the Kuruk-darja, wheeled round to the south, and emptied into the Kara-koschun, to which the Tarim was also bound, though by quite a different route. This abnormal hydrographical arrangement may be illustrated by the lower sketch on Pl. 35. Neither the Chinese texts nor the Chinese maps lend the slightest support to any such arrangement. On the Wu-tschang map, as well as upon the map of the *Si-jü-schuei-tao-ki*, the Tarim, after being joined by the Kontsche-darja, empties itself into the Lop-nor a long way east of the confluence. In the text of the last-mentioned we are told, as I have already pointed out above, that »the river Tarim flows east of Korla 200 *li*, and past Kara-schahr on the south, then another 200 *li* towards the east, south of Bostan-nur, and empties still farther east into the Lop-nor.» I have also pointed out that Lôu-lan was on the Lop-nor. Here I may also add the various names of the ancient lake which Himly has collected:

»Nach dem im *Shi-ki-tshöng-i* (der »richtigen Bedeutung des Shi-ki» oder der amtlichen Geschichte des Ssĕ-Ma-Thsien) angeführten Kwa-Ti-Tshi führte der Lob-Nur früher ausser den erwähnten (P'u-Thshang-Hai, Yao-Tsö und Yen-Tsö) auch die Namen: Fu-Zhi-Hai (»Sonnen-Stützen-Meer»), Lao-Lan-Hai (»Meer von Lao-Lan, Lou-Lan oder Leu-Lan»), Lin-Hai (»Nahes Meer»), woraus zu ersehen, was für verschiedene Namen er führte.»*

As I have discovered the ruins of Lôu-lan, it is plain that the Lôu-lan sea or lake of Lop-nor is identical with the depression which my levelling proved to exist in the northern part of the desert. And as it was in this depression that the Tarim disembogued »still farther east», it is difficult to defend the proposition, that the Kontsche-darja ever directly emptied itself into the Kara-koschun. Finally, I will quote one passage more from Himly's essay last referred to:**

»Das *Shui-King* sagt, das Gewässer (Khaidu-gol oder Kontsche-darja) mache eine Biegung und fliesse an der Westseite des Landes Khü-Li vorüber . . . . . Der alte Lauf des Kuei-Tzĕ-tung-thshuan (Ost-Flusses von Kutshe), auf dem er in den (Tarim-) Fluss gemündet hätte, sei östlich vom Lun-thai gewesen, und das Gewässer des Tun-Hung (Bagrash-Sees) dürfte nicht über Khü-Li hinausgehen . . . . . Der Khaidu macht hierauf nach dem Verfasser nochmals eine Wendung, und zwar nach Osten, worauf er in den Tarim-Fluss mündet.»

This description belongs to the epoch of »the three kingdoms» (221—280 A. D.), when the Tarim flowed through the bed of the Kuruk-darja, after having picked up the Khaidu-gol or Kontsche-darja.

Kosloff says further, that »without doubt there was a time when the »Lop-nor» extended a good deal farther north than it does now; but its southern shore occupied approximately the same position as it does at present, and along that same shore ran the same ancient route from Lop-nor to Sa-tscheo which Marco Polo travelled by six hundred years before me». The foregoing investigation shows however that in Marco Polo's time the Kara-koschun did not exist at all, and the question as to which route he travelled by between »the town of Lop» and Sa-tscheo is not yet settled. Since the hydrographical relations six hundred years ago were quite different from what they are now, it is extremely improbable that Marco Polo's route coincided with the existing road; its western part at any rate lay farther to the north than it does now. This fact is alluded to in the following passage of Himly's essay: »Nach dem *Shui-king-tshu* sammeln sich die Gewässer des Yao-tsö (i. e. Lop-nor) im Nordosten von Shan-shan, im Südwesten von Lung-thshöng (the Dragon Town).» With regard to the destruction of this place, the Chinese work goes on to say, »Das P'u-thshang-Meer strömte über seine Ufer und verheerte das Land, die Grundmauern der Stadt sind noch vorhanden. Im Zeitraume Tschi-ta (1308—11) wurde das am Morgen am West-Thor zuerst auftretende, am Abend durch das Ost-Thor entgegen fliessende und das über die Ufer fliessende Wasser durch den Wind gleichsam zu der Gestalt eines Drachen zusammengeweht».[*] The great lacustrine change, which happened, in conjunction with an exceptionally violent north-east storm, in 1308—11, took place 35 years after Marco Polo's journey (1274). The Dragon Town was destroyed to its very foundations by the overwhelming waters. This town was situated south-west of, or on the south-west shore of, the Yao-tsö (*tsö* = »marsh»), the then lake of Lop-nor. It may be regarded as probable, that the road from »Ciarcian» (Tschertschen) passed at that time through the Dragon Town.[**] The Chinese word for »dragon» is *loo* or *lou*, and Himly discerns a certain resemblance between this word and Lob and Lôu-lan.

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* *Ein chinesisches Werk über das westliche Inner-Asien*, p. 62.

** *Op. cit.*, p. 60.

Kosloff supposes that in the future the Tarim will return to the bed of the Ettek-tarim, and at the same time the Lop-nor (i. e. the Kara-koschun) will move to the south-west, and become joined to the Kara-buran, but »it (the lake) is hardly likely ever to desert the salt depression in which from antiquity the water of the Lop-nor has found a resting-place.» Both Bogdanovitsch and myself have expressed the opinion, that in time the Kara-koschun will travel up the river. But the state of affairs which I found to obtain in the years 1900 and 1901 has shown that this view is wrong; at any rate it was wrong then, for the lake was, as we have seen, spreading northwards, towards its old depression. It is however an incomprehensible sort of proof to say in one and the same breath, that the lake will probably move to the south-west and yet that it will at the same time never desert its ancient basin!

In the discussion to which I was invited in the Topographical Section in St. Petersburg, and at which the Russian geographers who were present attempted to defend the honour and dignity of the Kara-koschun and its right to be called the historical Lop-nor, one of my most noteworthy proofs, that this could not be the case, was the circumstance that poplar forest is entirely absent on the shores of the former, and alongside the Tarim downwards from Tschigelik-uj. To this observation I never received any satisfactory answer; and, so far as I now remember, the only suggestion offered was that the saliferous character of the ground rendered it less adapted for the growth of forests. In Kosloff's pointed reply to me I look equally in vain for any acceptable explanation of the absence of forest. He does, it is true, institute a comparison between the Lop-nor (i. e. Kara-koschun) and barren salt lagoons. As in the case of the latter, the wide-spread tracts of schor round the lake, sometimes as hard as stone, sometimes moist and heavily impregnated with salt, cannot but be destitute of vegetation. »On the immense expanses of schor which cover the greater part of Lop-nor vegetation can only thrive in the parts that are well supplied with fresh water, and even then it consists at first of grass and bushes only.» Then he goes on to say, »Let me once more emphasise the following fact, that formerly the Kontsche-darja abandoned its ancient bed, and now forms between Gerilghan and the Tokum-kul the easternmost arm of the system. At a later period the Kontsche-darja exercised an influence upon the oscillations of the lower Tarim; and every time the masses of water waxed uneasy in their bed there ensued an augmentation of the volume of the western waterway at the expense of the eastern (the Ilek), which was on the point of drying up. In proportion as the water receded step by step, in that same proportion did the vegetable life diminish, and close on the heels of this latter followed the sand-dunes, as they still continue to do, so that as the desert conquered ever wider and wider areas, it strewed its pathway with dead and smothered trees. The highest dunes built themselves up on the border-line between life and death, and it was only that far that the poplar forests and tamarisk bushes died out definitively. In moist places, and these sometimes occupied pretty extensive areas, there appeared here and there salt lagoons and very tiny patches showing traces of kamisch.»

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[*] *Ein chinesisches Werk* etc., p. 61.

[**] This is at any rate more probable than the assumption I first made, that the town of Lop was situated to the south of the present Kara-buran. But it is as yet impossible to determine its position with certainty; for just as the foundation walls of Merdek-schahr, which still exist beside the Merdek-köl, might answer to the Dragon Town, so might the ruins south of Kara-buran, on the road to Tscharklik, answer to the »town of Lob». The fact of Marco Polo not mentioning the Lop-nor suggests rather that the route he followed went south of the lake, though his silence on this point cannot be regarded as any sort of a proof.

With regard to the first point raised, it will be sufficient to call to mind, that in the whole of the western Kara-koschun, especially along the northern shore, the water is fresh; and that there is nothing in the properties of either soil or water calculated in the slightest degree to prevent the growth of forest is proved by the occurrence of abundant poplar woods in places beside the Tokus-tarim arm all the way from Schirge-tschapghan. No, the real reason is, that the Kara-koschun is so recent a creation that forest, which of course requires time to spread and grow up, has not yet been able to propagate itself into that region. But it will grow up there as time goes on, and in evidence of this I point to the solitary young poplars which have already struck root in a few, but a very few, places. Along several, and sometimes long, stretches of the Tarim, e. g. the Jumalak-darja, we have already noticed the absence of forest, the reason being that the river has changed its bed; and the same thing occurs again beside the great sandy desert below Karaul. Beside the Ettek-tarim and the Ilek, as well as beside the Tokus-tarim, we found, on the other hand, fairly vigorous forest, but then these streams have been stationary for a sufficient length of time.

Beside the lower Tschertschen-darja forest is absent from the point where one may properly speak of a delta, and where the river begins incessantly to change its bed. It is of course an obvious rejoinder to this, that there are also other parts of East Turkestan in which forest is absent where it might nevertheless be expected to occur. Why is there no forest, for instance, on the shores of the Tschöl-köl? Is that lake too so recent a formation that forest has not had time to grow up? From its position one might readily infer that it is quite old. The existence of a lake lying on the flat, as Lalmoj does, is necessarily precarious, and sooner or later it is bound to be filled up and disappear. A similar fate may well threaten the Tschöl-köl, but its existence appears to be in some way bound up with that of the Tschoka-tagh, at the western foot of which it is situated; and similarly with the Jughan-balik at the north-western foot of the Tusluk-tagh and the Schor-köl at the western foot of the Masar-tagh. Our knowledge of the meteorology of this region is too slight to justify us in drawing any definite conclusions from this parallelism. But whether it be, that the corrasive force of the wind has been intensified at the western foot of these mountains by reason of the mere presence of the obstacle, the ground being in consequence more deeply excavated there than elsewhere, or whether it is the mountains which have protected the lake-basins and prevented them from getting filled up with drift-sand and dust, it is at any rate certain, that lakes such as these are more permanent and of greater age than the marshes and marginal lakes of the open flat-land. And yet forest is absent on the shores of the Tschöl-köl! Beside the Sorun-köl, which lies to the north of it, there stand a few solitary poplars, as there also do beside the Jughan-balik; and again by the side of the long string of marginal lakes lying west of the last-named, beside which I travelled on 18th April 1895, the forests are very thick and luxuriant. The reason why the Tschöl-köl alone is destitute of forest would therefore appear probably to be this, that during certain periods the lake has dried up, for example when the Jarkent-darja flowed along the bed of the Kodaj-darja. At that period the lake, contrary to its northern neighbours, lay at too great a distance from the river for its vegetation to be able to survive the interval of drought. Now neither this, nor anything similar to it, can have happened in the case of the Kara-koschun; for since its formation in 1740 this lake has never been perfectly dry.

With regard to the second part of the passage I have quoted last from Kosloff, the statements he there makes are not quite correct. There have of course been periods in which the eastern waterway (Ilek) has gradually dried up, while at the same time the western (Tarim) has proportionally increased. But that has only been one phase in a process of unceasing oscillation; for a comparison of my observations of 1896 with those I made in 1900 proves that, when the eastern waterway increases in volume, the Tarim diminishes. The account I have given of the Tarim in the first volume of the present work shows how unstable its hydrographical system is as a whole.

Kosloff gathers to a head his criticism of my former comments in the following words: »From all I have said above it follows that the observations made by Sven Hedin are to be explained in a different way: the desolate region lying east of the lakes which he discovered was formed, not by the Lop-nor, for it lay a full degree farther south, but by the Kontsche-darja in its uninterrupted effort to flow towards the west; and the Ilek, with its lake-like expansions, and the belt of salt lagoons and marshes which accompany its eastern bank, are really but paltry remnants, *not* again of the Lop-nor, but of the curving of the migratory river.»

»These facts and these explanations disprove the arguments which Sven Hedin has adduced in support of his hypothesis of the existance of a former and second Lop-nor.»

»The only conclusion I am able to draw from the whole of the foregoing investigation of the Lop-nor problem is, that the Kara-koschun is not only the Lop-nor of my revered teacher N. M. Prschevalskij, but also the ancient historical and true Lop-nor of the Chinese geographers.»

In these words Kosloff defines the standpoint he assumed after my first journey to the Lop-nor country. How little tenable it was is clear from my later explorations. One idea which I entertained in 1896 I have seen cause in some respects to change since my fresh visit to that region. I was earlier of opinion that the chain of lakes, Avullu-köl, Kara-köl, Tajek-köl, and Arka-köl, were surviving remnants of the ancient Lop-nor, transformed in shape and altered as to position. That idea is however only in part correct, in so far as these lakes do lie in the same depression as the old Lop-nor, and so far forth may be regarded as newly arisen descendants of that lake. But on the other hand it is doubtful whether the position of the lake has been altered by winds and sand in the way I formerly represented. It is indeed quite true, that these two natural powers are at this moment encroaching upon the eastern shores of these lakes, the dunes penetrating into the water and so advancing westwards across the lake, while the vegetation gets left behind, so that in their present stadium their eastern shores may be said to be travelling west, but it is not credible that this process has been going on since the time of the old Lop-nor, and is still incredible even when we suppose that there have been arid intervals in between. At the present moment I am unable to decide the question, though, now that the basin of the old Lop-nor has actually been discovered, it is a question of no importance. How *far* to the east these four lakes extended at the maximum can only be determined by fresh journeys in the Desert of Lop; and even then it would be difficult to arrive at a final solution, because the sand, under which the entire region lies buried, is pretty high and difficult immediately east of the lakes. In any case Kosloff has no right to attempt to reduce the dimensions of these lakes. Although he has never seen them himself, he nevertheless takes it upon him to declare, that they really are nothing more than expansions of the Ilek. Is it not indeed just to such riverine expansions as these that we generally do apply the term lakes? And as for the lakes in question, we have found that they contain depths nearly twice as great as even the maximum depth of the Kara-koschun. Moreover a comparison between the mean depth of the Kara-koschun and the mean depth of this eastern chain of lakes yields very interesting results. The mean depth in the current which traverses the northern part of the first-mentioned lake is, we found, 2.7 m., and that of the southern 1.0 m., the mean of all the soundings being 2.366 m. Taking into account the approximate dimensions of the lake and the volume it receives, we calculated that its real mean depth is 0.81 m. In the several lakes of the eastern waterway the mean depths are as follows:

Arka-köl . . . . . . . . . . . . . = 5.80 m.
Tajek-köl . . . . . . . . . . . . = 6.50 »
Kara-köl . . . . . . . . . . . . . = 5.32 »
Avullu-köl . . . . . . . . . . . . = 3.92 »
Tschivilik-köl . . . . . . . . . . . = 4.07 »

The mean of all the soundings which I took in these five lakes, 38 in number, amounts to 4.78 m. The mean of all the soundings taken in the Kara-koschun amounts to 2.366 m. Thus the mean depth of the Kontsche-darja lakes is exactly double the mean depth of the Kara-koschun. And even though the water-surface of these small lakes lies a few meters above the water-surface of the Kara-koschun, nevertheless there may be portions of their bottoms which lie at a lower absolute altitude than the deepest hollows in the Kara-koschun depression. Earthy islands, holms, and reedbeds are incomparably smaller and fewer in the Kara-köl lakes than in the Kara-koschun: the former give the impression of possessing more of the character of real lakes. We have estimated, that the volume of the Kara-koschun in the beginning of April amounted to 2500 million cub.m. If we regard the Kara-köl system of lakes as a whole, 40 km. long and 10 km. broad on an average, then, with a mean depth of 4.78 m., its volume amounts to 1900 million cubic meters. And although this figure is not strictly comparable with that for the Kara-koschun, since in the latter case the shallow reed-fields are also taken into account, we find nevertheless that, although the area of the Kara-köl lake-system is only one-sixth of the area of the Kara-koschun, yet their cubic contents are not far from being as great as the cubic contents of the Kara-koschun. Anyway it is not right to describe them as »but paltry remnants of the migratory Kontsche-darja.»

In this critical examination of the rejoinder which Kosloff has made, in his book issued in 1899, to Richthofen and myself, I believe I have now dealt with all the so called »proofs» which he advanced for his identification of the Kara-koschun with the Lop-nor. I should not have dwelt so long upon this question, were it not for the insistent energy with which Prschevalskij's views have been defended by Kosloff and several other russian geographers. I do indeed regard with the greatest esteem Kosloff's wish to preserve for his great teacher, Prschevalskij, the honour of being the first discoverer of the Lop-nor, and I attest my admiration for the valuable, exact, and persevering explorations which Kosloff himself has carried out in the country of Lop; but scientific truth must take precedence over all such considerations as these. And it is clear that as our material increases our views will be widened, and the entire problem will be set in a more distinct and intelligible light in proportion as the region becomes better known. It is unfortunate for Kosloff, that he should have placed such blind confidence in Prschevalskij's views as to the position of Lop-nor, for they rest upon no convincing proof. By doing so he has done himself an injustice and detracted from the value of his discovery of the Kuruk-darja, for he came across it just at the point where the old river issued into the ancient lake. When he published his book Kosloff was the only European who had seen the northern shore of the old Lop-nor, and its poplar-trunks, at least at a distance; but unfortunately he did not know how to interpret what he saw. Had he gone a few kilometers farther south and discovered the ruins of Lôu-lan, he would certainly have arrived at a very different opinion.

Before concluding this section of the work I should like to express my sincere thanks to Chaptain P. K. Kosloff for the fair and chivalrous manner in which he has on his side carried on the discussion. For my own part, I look upon the firmness and tenacity with which he clings to his views in the light of an advantage; for if he had not defended them with such warmth, I should never have returned to the Desert of Lop, and so should have missed the discoveries which I was fortunate enough to make there. Consequently it may be said, that our interchanges of opinion have proved to the advantage of geographical inquiry.

In November 1902 I delivered a lecture on my last journey before the Imperial Russian Geographical Society, and at a dinner at the house of the Vice-president of the society, P. P. Semenoff, where I met most of the Russian students of Asia who where then living in St. Petersburg, I had a further opportunity of discussing my views with regard to the new phase of the Lop-nor question. I was delighted to find that there was then no longer any opposition to my views, and I am convinced that the Russian geographers have now abandoned Prschevalskij's standpoint, a circumstance which, need I add? does not in the slightest degree detract from Prschevalskij's honour or in any way dim the lustre of the fame which will attach to his memory to distant generations. He was at all events the first European explorer in the Lop country, the first to make us acquainted with its strange geography and its people; nor has his masterly description ever been excelled. The more detailed explorations which his successors have been enabled to carry out, and which have resulted in an accurate knowledge of that part of Asia, have in every case been built up upon the solid foundations that he laid.

On 7th December in the same year I delivered the same lecture before the Royal Geographical Society in London. As on its conclusion Delmar Morgan did not venture to offer any criticism, I conclude that he too has abandoned his former standpoint. On the other hand Prince Krapotkin spoke, and as his speech gave evidence of considerable reflection, I will quote that part of it which refers to the Lop-nor:

»As to his levelling in the Lob-nor desert, and the archæological discoveries which Hedin has made in the country of Lob-nor, they will certainly throw new light on the changes which have been going on in the basin of this great Central Asian lake. With regard to Lob-nor, I will permit myself to remark that I do not think that the lake Kara Koshun — that is, the Lob-nor of Prjevalsky — can be considered as anything else but the present remainder from the great lake Lob-nor. But what appears to me almost quite certain, after Sven Hedin's surveys, levellings, and discoveries, is that there was first a time when Lake Lob-nor covered the whole of the triangular space which is limited on the west by the southward course of the Tarim, on the south-east by the lake Kara Koshun, and on the north-east by the escarpment of the Kuruk-tagh, which runs in a north-west to south-east direction. The place of the Sixty Springs, Altimish-bulak, which had been visited previously by the Russian explorers, and lies, according to their determinations, at an altitude of 3600 feet, stands on the border of the escarpment, and the triangular space between the escarpment, the Tarim river, and the plains which spread at the foot of the Altyn-tagh, must have been occupied some time by a large basin, upon the shores of which stood that spot of the Lau-lan region, in which Dr. Hedin has found such interesting manuscripts. Later on, the lake occupied the eastern part only of that triangular basin; and now the lake Kara Koshun, or the Lob-nor of Prjevalsky, represents the southern trough of that depression, which continues still to be occupied by what has survived of the Lob-nor. At any rate, when the full reports and the levellings of Dr. Hedin are published, and the whole region is better explored, it will certainly appear that within this triangular depression (»Lob Nor desert» on *Stieler's Atlas* map) the lake was changing its position in proportion as it decreased, and it may change it several times more before the general desiccation of Central Asia, which is going on at great speed, will finally move the Tarim lake further south-westwards to meet the Cherchen, and finally reduce what will remain of the Lob-nor to the little lake Kara buran, which we see at the junction of the Yarkand-daria with the Cherchen.»

Prince Krapotkin commits here a double mistake. In the first place he removes the Lop-nor problem from the period of actual history, and regards it from the standpoint of geological history, carrying us back as far as the epoch at which the Asiatic Mediterranean was still in existence, forgetting that the Lop-nor problem belongs to the very latest phase of the Quaternary period. And when he converts the triangle between the lower Tarim, the Astin-tagh, and the »Altmisch-bulak escarpment» into an ancient great lake Lop-nor, and gives to the spring of Altmisch-bulak an altitude of 3600 feet or 1100 m., he forgets that the absolute altitude which he thus assigns to the northern shore of his imaginary lake would not allow the waters to remain within the boundaries he assigns to them. Such a lake as he supposes would extend a good bit west of Tschimen and Schah-jar, and cut the existing Tschertschen-darja between Tatran and Boghuluk. To the north this immense lake would reach to within a short distance of the road running between Kutschar and Tschadir, would embrace Kara-schahr and the whole of the basin of the Baghrasch-köl, and eastwards would extend as far as Sa-tscheo. Under no other conditions would it be possible for the triangle in question to be under water. And this brings us to the question of the great Asiatic basin which Richthofen calls the Han-hai, and with regard to which he says *inter alia:*

»Nur ganz allgemein steht fest, dass das Meer am Ende der Kreideperiode das Han-hai erfüllte; dass es aus dem durch die Flüsse herzugeführten Material, insbesondere Sand und Geröll, Schichten absetzte, und sich in einer unbestimmten späteren Periode durch die Dsungarei zürückzog; und dass es dabei auf seinem früheren Boden ein grosses Binnenmeer zurücklies, welches durch allmälige Verdunstung in mehrere wassererfüllte Becken zerfiel, sowie dass auch diese allmälig an Grösse abnahmen, zum Theil ganz austrockneten, zum Theil aber noch in kleinen Ueberresten als Salzseen vorhanden sind.» And further: »Mag nun die Isolirung des centralasiatischen Mittelmeeres in einer etwas früheren oder späteren Epoche der Tertiär-periode erfolgt sein, so wird dasselbe immerhin noch als ein grosses Binnenmeer einen Bestand durch lange Perioden gehabt haben, ehe es zu geringen Dimensionen zusammenschrumpfte.»*

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* *China*, I pp. 108—109.

The Lop-nor is indeed the last remnant of a former lake-basin of the Han-hai; but in identifying this lake-basin with the great lake of Lop-nor, of which »Kara-koschun is the present remainder,» Prince Krapotkin puts back the problem to such a remote period of the world's history that neither Lop-nor, nor Lôu-lan (which he places on the shore of this gigantic lake), nor even the Chinese themselves as yet existed. What we call the Lop-nor problem, the problem we are consequently discussing, has nothing whatever to do with wide-reaching basins of an older geological period, but it is concerned with a period so recent as to come within the compass of actual documented human history, and with the help of human documents we are in a position to follow in part the actual course of the hydrographical occurrences.

Why the lake, after shrinking to the requisite extent, should settle into the eastern part of this triangular area, I do not understand, for no traveller has ever been in that part. In taking the Kara-koschun to be all that now remains of the Lop-nor, Prince Krapotkin is virtually adopting Prschevalskij's standpoint. But when he goes on to say, that the lake »was changing its position in proportion as it decreased, and it may change it several times more », he adopts my point of view, nor can I venture to reconcile these two different opinions. For when the Lop-nor dried up and the Kara-koschun was formed — it was precisely then that the terminal lake of the Tarim system altered its position. Prince Krapotkin calls this terminal basin »the Tarim Lake», a most happy designation, for generally speaking by this must be understood the lake into which the Tarim empties itself no matter whether it be situated in the north or in the south of the desert. When the Tarim lake lay in the north the Chinese called it Lop-nor, but after it migrated to the south it was called by Mongols and Turks the Kara-koschun. Both hydrographically and genetically therefore the Kara-koschun plays precisely the same role that the Lop-nor formerly did, although geographically and topographically they are two different lakes. In other words, it is the same lake occupying two quite different positions; and Prince Krapotkin is perfectly justified in supposing that this migration may still be repeated several times again. On the other hand the Kara-koschun will not become joined with the Kara-buran, for the latter is on the point of being filled with sedimentary matter, and hence of totally disappearing, whereas the Kara-koschun, as we have seen, began to return in earnest towards the north in 1901.

In the preceding pages I have recalled the principal moments in the polemic with regard to the Lop-nor, and have pointed out that none of the English or French travellers who have visited the region has in any degree made the slightest contribution towards the solution of the problem. Nevertheless there is one notable exception, a man who is intimately acquainted with both the geography and the history of Central Asia, who, although he has not himself visited the country of Lop, has nevertheless formed his own opinions regarding it, and that in such a clear and ready way, that I feel I ought not to pass him over unmentioned in this connection. I mean Mr. F. Grenard, who took part in J.-L. Dutreuil de Rhins's journey across Asia in 1890—95, and who has published a very excellent and valuable account of the results of the expedition, under the title of *Mission Scientifique dans la Haute Asie.* In a chapter devoted to a general account of the geography, Grenard has occasion to refer to the hydrographical relations of East Turkestan. After discussing the question of the desiccation of the basin, he proceeds to deal with the Lop-nor problem. With regard to the desiccation he says *inter alia:* Je ne pense point qu'en quinze cents ou en deux mille ans l'eau ait diminué d'une manière très sensible dans les rivières. A l'époque des Han, les rivières de Khotan et de Yàrkend contribuaient seules à former le Tarim et le Kéria daria se perdait dans les sables alors comme aujourd'hui.»

In another place in this work I have proved, that in respect of this matter I am of precisely the same opinion as Grenard; the climatic changes which take place in the heart of the great continent would require enormous periods before they could effect any material variation in the volumes of the rivers and lakes of East Turkestan. That a process of desiccation is indeed going on admits of no doubt whatever; in fact, it has been sufficiently proved, especially by von Richthofen. But the historical period is, as already mentioned, all too short, even when we appeal to the oldest extant documents, to allow of our pointing, on the strength of their authority, to any appreciable diminution of volume. Stein has, I know, suggested the possibility, that as late as the 16th century the Kerija-darja still flowed all the way to the Tarim, his opinion resting upon information furnished by Mirza Hajdar. And the strips of toghraks and tamarisks that lie to the north of the Kerija-darja seem to render this supposition possible; but I am disposed to think that Grenard is more likely to be right, when he suggests that this river was cut off from connection with the main artery of the system as early as the Han period. His statement, that the Chotan-darja and the Jarkent-darja alone formed the Tarim must however be due to an oversight, for at that period it was the Ak-su-darja which contributed the largest volume to the Tarim, just as it does at the present day.

Grenard's observations, that the Chotan-darja, Kerija-darja and Tschertschen-darja have all eroded their left, i. e. their west, bank to a greater extent than they have eroded the opposite bank, and that the Jurun-kasch has during the last ten or twelve centuries shifted its bed some hundreds of meters towards the west, are both of the greatest interest. Nevertheless he does not consider, and rightly, that this fact is sufficient to warrant the postulation of a general law, and he holds it to be an exception, that since the 6th cent. A. D. the Tschertschen-darja has shifted its channel a good deal to the east, namely from At-lasch. And with this Roborovskij agrees, in that he looks upon the depression, in which the Ketme-kuduk is situated, as being a former bed of the Tschertschen-darja. But, as I have myself crossed over this channel, and ascertained that it is formed by streams which come down from Atschan, Isengän, and Kontsche-bulak, and as I moreover, whilst travelling westwards from Tschertschen, failed to discover any other ancient river-course that might erroneously be taken to have formerly belonged to the Tschertschen-darja, I ventued to express (vol. I p. 371) the opinion that this river, at all events in the vicinity of the town of Tschertschen, has not changed its bed. Nevertheless Grenard's observation is noteworthy, namely that it is precisely in the zone where these rivers give life to the oases that they migrate to the west, whereas no sooner do they enter the desert than they distinctly tend to the east, that is erode their right bank the more — a fact which I myself had several opportunities of observing.

Grenard's views with regard to the Lop-nor are based upon the statements of Russian travellers, upon Richthofen's criticisms, and upon information which he himself received from the natives. But he seems to have had no sort of knowledge of the investigations which I made in 1896, and published the same year in *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* and in *Petermanns Mitteilungen*, at all events he makes no mention of them in his discussion, which appeared in the year 1898. The mistake into which he falls is easily explained, on the ground that he himself never visited the country of Lop, so that he draws the same erroneous inferences as, for instance, Delmar Morgan and Krapotkin have done. But in this historical sketch of the Lop-nor problem it would be an oversight not to allude to his contribution to the question. After explaining that the variability of the Lop-nor and neighbouring lakes is due to the inconstancy of the rivers, he proceeds: »Toutefois le Lob-nor même a été non pas déplacé, mais réduit par suite de la faiblesse des rivières qui l'alimentent, du limon qu'elles apportent et de l'évaporation très active à laquelle il est soumis. Le sol porte des traces d'une plus grande extension de la nappe aqueuse à une époque antérieure, et il est probable que le Kara Bourân s'étendait primitivement jusqu'à l'ancien confluent du Tarim et du Tchertchen-daria par 39° 54′ de latitude. De même le Kara Kochoun devait s'étendre un peu plus au nord alors qu'il recevait le Kontche daria sur sa rive septentrionale. La carte des Ta Ts'ing nous montre sur la rive septentrionale du Kara Kochoun quatre petits lacs qui n'existent plus aujourd'hui; c'étaient évidemment des lacs formés par le Kontche daria, qui ont disparu lorsque cette rivière a cessé de les alimenter. En se reportant à l'ouest, le Kontche daria en a formé quatre nouveaux qui ont remplacé les anciens et sont situés au nord-ouest de ceux-ci, le long du bras oriental actuel de la rivière. Ces lacs, dont j'ai eu connaissance par les indigènes, se nomment à partir du nord: Kara koul, Tayek koul, Sougout koul, Tokoum koul. . . . Que ces lacs, qui n'en font qu'un seul en été . . . soient récents et causés uniquement par le Kontche daria, c'est ce dont on ne peut douter un moment.»

In analysing this passage I would call attention to the contradiction involved in first saying that the volumes of the rivers have not appreciably diminished during the last two thousand years, and then that the Lop-nor has, not indeed altered its position, but diminished, because of the feebleness of the rivers that feed it. To affirm that the Kara-buran formerly extended all the way to 39° 54′ N. lat., that is to say as far as the ancient confluence of the Tarim and the Tschertschen-darja, is too bold an assumption to make; all the same it is fully excused through Roborovskij's hasty and misleading assertion, that the Tschertschen-darja formerly followed a much more northerly course through the desert. That the Kara-koschun has at times had a greater extension than it has now we know from direct observations made during the last 25 years, but the traces which those temporary extensions have left behind them, even at pretty considerable distances from the existing shores, have nothing to do with the desiccation of the basin of Central Asia, for this has been going on for countless ages; they depend rather upon oscillations in the volume, occasioned by the formation of marginal lakes and other factors mentioned above. On the other hand the Kontsche-darja has never terminated at the northern shore of the Kara-koschun. Grenard throws out the idea, which is not only very original, but also in part perfectly correct, that the four small lakes formed by the Kontsche-darja, and depicted on the Chinese maps to the north of the large lake, have dried up since this river shifted its course to the west, but have once more come into being in another place and under another form since the river began to flow along its new bed. It is in fact closely akin to the theory which I formed after my first visit in 1896, but subsequently abandoned. Curiously enough, Grenard has, like Kosloff and Pjevtsoff, possibly to some extent misled by them, confounded together two or three of the lakes that belong to the eastern waterway (Ilek) with the lakes that lie along the eastern bank of the Tarim. For instance, he speaks of the Kara-köl, Tajek-köl, Sogot-köl, and Tokum-köl; whereas Pjevtsoff mentions also the Tschiminlik (a lake I never had the good fortune to come across), the Sogot, Tal-kitschin, and Tokum-köl, while Kosloff interchanges the Sogot and the Arka-köl. All this confusion admits of an easy explanation — these travellers have never visited the localities in question — and it is quite excusable, in so far as they are not attempting to buttress up an error once disproved, for it is indeed not easy, even to one who has visited that region, and visited it by boat, to disentangle its labyrinthine waterways. Grenard's view, that in summer the eastern lakes merge together into one, which is fed exclusively by water from the Kontsche-darja, is only in part correct. We might indeed say, that the Avullu-köl, the Tajek-köl, and the Arka-köl do form one meridional lake at the high-water period, only that does not take place in summer, but in the spring, after the thawing of the ice, and in autumn, when the freshets derived from the melting of the snow and ice in the mountainous regions at length get down to those lowland tracts. As we have already seen, the Tarim participates to an essential degree in the formation of the eastern chain of lakes.

Grenard continues: «Si le Lob nor a diminué, il ne faudrait point croire qu'il ait jamais eu une profondeur importante ni qu'il ait, dans la période historique, englobé dans une masse d'eau unique le Kara Bourân, le Kara Kochoun et les lacs avoisinants. Les Annales des Han antérieurs appellent le Lob nor *Pou-tchang hai*, c'est à dire le lac abondant en roseaux, ce qui prouve que dès avant notre ère le Lob nor participait du marécage autant que du lac. Elles ne citent qu'un seul lac, mais nous ne devons pas en conclure qu'il n'en existait qu'un seul. On trouve dans les annales suivantes d'autres noms qu'on a cru être des noms différants et successifs d'un seul et même lac, or, comme Dutreuil de Rhins le fait justement remarquer, cela n'est nullement démontré. Aujourd'hui tous les Turcs orientaux donnent à ce Pou-tchang hai le nom mongol de Lob nor, plus géneralement usité que les dénominations particulières de Kara Bourân et de Kara Kochoun; et, fait à noter, ils l'appliquent à la fois à l'un et à l'autre de ces lacs; par consequent le Pou-tchang hai des Han ne designe pas nécessairement un lac unique. Une carte chinoise, que nous avons trouvée au yâ-men de Kéria, dressée au siècle dernier d'après l'atlas des Ta Ts'ing, mais complétée et corrigée depuis d'après des renseignements pris sur place, donne au Kara Bourân le nom de Ta Lob nor, le Grand Lob nor; elle le fait beaucoup trop vaste, mais le place assez bien par 39° 30′ de latitude, quoique trop à l'est par 26° de longitude ouest de Pékin. Les chinois ont ainsi corrigé d'eux-mêmes l'erreur de la carte des TaTs'ing sur laquelle le Lob nor est situé un degré trop au nord.»

The idea here suggested, that the various names given in the different Chinese chronicles to the different terminal lakes of the Tarim are all successive names of one and the same lake, is certainly correct. At all events it is *a priori* in a high degree probable, precisely because the terminal lake of the Tarim has at all times had a position of but little permanence. It was because of its migratory character that, after my first journey to the Lop-nor, I called it »the travelling lake«. It is very likely that a lake which time after time changes its position will also change its name. On the other hand Grenard makes a mistake in saying, that the East Turkestan tribes use the name Lop-nor more frequently than they do the names Kara-buran and Kara-koschun. Although I have traversed that country in every direction, I have never heard the Turkish tribes employ the classic designation; in fact, they generally fail to give any answer at all when you ask them where Lop-nor is situated. And it is easy to understand why they are unable to do so. They know of course the country of Lop, which extends alongside the river from Al-katik-tscheke to Tusun-tschapghan, and they call themselves Lopliks; they are acquainted, further, with the names Kara-buran and Kara-koschun, and the Kara-köl lakes, besides a number of marginal lakes; but they have never heard, and *never can* have heard, speak of a lake bearing the name of Lop-nor, for the simple reason that the lake in question had disappeared long before those tribes arrived in the country. On the other hand the Mongols frequently employ the name Lobo-nur or Lovo-nur, and so do the Chinese. Of the latter it is however only the educated who know that the old lake lay north of the existing one. The Chinaman, who according to Grenard, applies the name »Ta Lob nor» to the Kara-buran, commits a serious error.

To this Grenard appends an interesting note, containing an opinion which Himly also has suggested, so that I quote it here: »Ce nom (Lob nor) n'apparait pas avant le XIII^e^ siècle, époque où les Mongols ont occupé la région pour la première fois. Mais, si *nor* est exclusivement mongol, Lob est sans doute le vieux nom local du pays appelé Leou-lan et Chan-chan dans les plus anciens textes chinois. Il n'est pas impossible que le *Na-po-po* de Hiouen Ts'ang et le *Napaci* de Pline ne soient des transcriptions de ce nom.«

The resemblance that Grenard thus suspects becomes all the greater if we write the name as Himly does, namely Lôu-lan. The first syllable would thus be transferred to the lake; and after the Mongol word »nor», meaning »lake» is added to it, it becomes Lôu-nor.

Grenard's intervention in the Lop-nor question, witnessing as it does to great acuteness and accuracy, is however impaired by the final passage, which I will now proceed to quote. It is quite excusable, that he should have adopted the views of Prschevalskij and other Russian travellers who have visited those regions rather than the views of Richthofen, who has never been there. My first journey in the Lop country seems, as I have already mentioned, to have escaped his attention. He says:

»Nous croyons que M. de Richthofen n'était point dans le vrai en soutenant que l'ancien Lob nor était un autre lac que ceux vus par Prjévalsky sous prétexte que la latitude donnée par ce voyageur ne correspondait point à celle de la carte chinoise. Une erreur d'un degré sur une carte chinoise n'a rien d'extraordinaire, surtout pour un point situé hors des grandes routes. M. de Richthofen a démontré ou a cru démontrer qu'un lac à bassin fermé ne pouvait avoir les eaux douces, mais nous avons rencontré au Tibet des lacs à bassin fermé dont l'eau est douce et tous les indigènes que j'ai consultés ont été d'accord pour affirmer que les eaux du Lob nor sont salées, sauf sur le chenal du Tarim. Quant à l'argument tiré de ce que Marco Polo ne parle point du Lob nor, je m'étonne qu'il ait été émis: Marco Polo qui est toujours très bref ne cite pas à beaucoup près tout ce qu'il a vu ni tout ce dont il a ouï parler et il ne prévoyait pas que les savants futurs se querelleraient à propos d'un lac qui pour lui n'était qu'un marais insignifiant. La tradition indigène est trop ferme et trop précise pour que l'on se risque à placer le Lob nor autre part qu'elle ne le met. *

Confining myself to one or two observations upon this passage. The self-contained lakes, with fresh water, which Grenard visited in Tibet will certainly have a subterranean outlet, and their isolation is only apparent. I have myself seen several lakes of this character in Tibet. A lake that occupies the lowest depression in a basin, and possesses neither visible nor invisible outlet, must of necessity become salt. It is for this reason that the water of the Kara-koschun turns salt, and its salinity will continue to increase as the years go on. Marco Polo's omission to describe, or even mention, the Lop-nor is now a matter of no consequence. All the same, if he had heard anything about the existence of an extensive lake, with inhabited shores, in the middle of the desert, I do not believe he would have said, that it takes a whole year to cross the Desert of Lop. It is true, that in most cases local tradition is very reliable: yet to this credibility there exists a limit, and that limit does not extend beyond many generations backwards. This applies with especial force in the case of a lake which has had for successive masters, first the Chinese, then the Mongols, and finally the Turks. Of the earlier phases of its history the last-named possess not the slightest inkling.

If then Grenard has not made any noteworthy contribution to the solution of the Lop-nor problem — as that problem stood in 1898 — what he says upon the question is of great interest, albeit, now that the question is definitively solved, it is the interest of curiosity only.

Finally I may add that Mr. Henri Cordier has given a most interesting and valuable resumé of the Lop-nor problem in his new edition of Yule's Marco Polo. Cordier is quite right when he expresses his own opinion in the following words: »There is no doubt as to the discovery of Prjevalsky's Lob-nor, but this does not appear to be the old Chinese Lob-nor; in fact, there may have been several lakes co-existent; probably there was one to the east of the mass of water described by Dr. Sven Hedin, near the old route from Korla to Shachau: there is no fixity in these waterspreads and the soil of this part of Asia, and in the course of few years some discrepancies will naturally arise between the observations of different travellers.» Although this passage was written before my last journey, it perfectly agrees with my new discoveries in the Lop-nor region**

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* F. Grenard (J.-L. Dutreuil de Rhins). »*Mission Scientifique dans la Haute Asie, 1890—1895*«. Vol. III. pp. 192 ff.

** The Book of Ser Marco Polo. Vol. I. p. 198 ff.

# CHAPTER XXII.

## ANALYSIS OF AUTHOR'S SURVEY OF THE DESERT.

In Chapter XVI I have given a brief description of the general character of the Desert of Lop from the point of view of its physical geography, and in Chapter XVII a general account of the manner in which, and the circumstances under which, my survey of that desert was carried out, from the northern shore of the ancient Lop-nor at Lôu-lan to the eastern part of the northern shore of the Kara-koschun. In order not to lose the chronological sequence of the various phases of the Lop-nor problem, I have interpolated an account of the historical aspects of the question, together with a critical examination of some Chinese maps. I must now submit my survey-line to a closer analysis.

In the following table I have recorded all the readings I made, both backwards and forwards, the differences between the several pairs of readings, the altitude of each of the 346 stations in relation both to the point of departure and to the level of the Kara-koschun, the distances between the staff and the telescope and between the telescope and the staff, the bearings of each successive section of the traverse, and finally the situation of the seven camps at the end of each day that we were engaged upon the work.

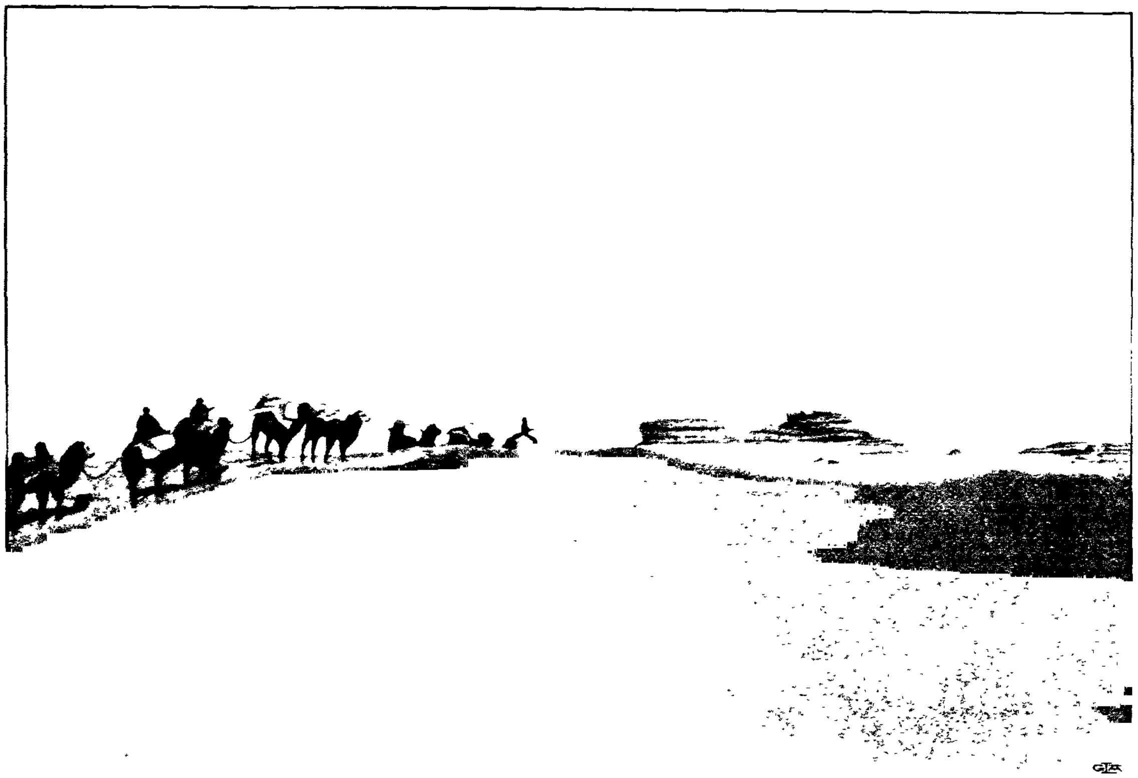


Fig. 156. A SOLITARY JARDANG IN THE SAND.

| Camp. | Number of station | Date | Backwards | Forwards | Difference. | Above starting point — | Below starting point — | Above surface of Kara-koschun | Below surface of Kara-koschun | Distance in m from staff to tube | Distance in m from tube to staff | Direction from staff to tube. | Direction from tube to staff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| CLIX | 1 | 10 | 3,148 | 1.630 | + 1.518 | 0.000 | 0.000 | 2,282 | — | 100 | 100 | S 29 W | S 71° E |
| | 2 | | 0.855 | 0.015 | + 0.840 | 2,358 | — | 4,640 | — | 100 | 59 | S 64° E | E |
| | 3 | | 1.755 | 3.523 | − 1.768 | 0,590 | — | 2,872 | — | 120 | 110 | S 45° E | S 39 E |
| | 4 | | 2,110 | 1.010 | + 1.100 | 1,690 | — | 3.972 | — | 100 | 100 | S 8° E | S 1 E |
| | 5 | | 1.375 | 1.184 | + 0.191 | 1,881 | — | 4,163 | — | 113 | 100 | S 4° E | S 66° E |
| | 6 | | 1.178 | 0.988 | + 0.190 | 2.071 | — | 4.353 | — | 84 | 100 | S 60° E | S 5 E |
| | 7 | | 0.330 | 0,648 | − 0.318 | 1.753 | — | 4 035 | — | 100 | 57 | S 33° E | S 31° E |
| | 8 | | 1.365 | 1.942 | − 0.577 | 1,176 | — | 3.458 | — | 100 | 100 | S 35 E | S 15° E |
| | 9 | | 1,455 | 0.834 | + 0,621 | 1.797 | — | 4,079 | — | 100 | 100 | S 66 E | S 41 E |
| | 10 | | 1,575 | 1.465 | + 0,110 | 1.907 | — | 4.189 | — | 100 | 100 | S 28° E | S 19 E |
| | 11 | | 1,164 | 0.562 | + 0.602 | 2.509 | — | 4.791 | — | 100 | 100 | S 29° E | S 11° E |
| | 12 | | 1,777 | 1.915 | − 0,138 | 2,371 | — | 4.653 | — | 100 | 100 | S 7° E | S 18° E |
| | 13 | | 1,525 | 2.145 | − 0,620 | 1.751 | — | 4.033 | — | 100 | 100 | S 28° E | S 20 E |
| | 14 | | 1,395 | 1.995 | − 0,600 | 1.151 | — | 3.433 | — | 100 | 100 | S 19° E | S 13 E |
| | 15 | | 2.856 | 2.543 | + 0,313 | 1,464 | — | 3.746 | — | 100 | 100 | S 8° W | S 11° E |
| | 16 | | 2.314 | 2.628 | − 0.314 | 1.150 | — | 3.432 | — | 100 | 100 | S 8 E | S 5° E |
| | 17 | | 1.195 | 0,823 | + 0.372 | 1.522 | — | 3.804 | — | 100 | 100 | S 12 E | S 11° E |
| | 18 | | 1.465 | 1.898 | − 0 433 | 1.089 | — | 3.371 | — | 110 | 100 | S 1 E | S 28 E |
| | 19 | | 1.970 | 3.200 | − 1.230 | — | 0,141 | 2.141 | — | 100 | 185 | S 11 E | S 18 E |
| | 20 | | 3.660 | 3.728 | − 0.068 | — | 0.209 | 2.073 | — | 87 | 100 | S 11 E | S 12 E |
| | 21 | | 2.525 | 2.079 | + 0.446 | 0.237 | — | 2.519 | — | 100 | 100 | S 20 E | S 15° E |
| | 22 | | 2,600 | 1,555 | + 1.045 | 1.282 | — | 3.564 | — | 100 | 100 | S | S |
| | 23 | | 2.635 | 3.300 | − 0.665 | 0,617 | — | 2,899 | — | 100 | 100 | S 17 E | S 12 E |
| | 24 | | 3.015 | 1.735 | + 1.280 | 1,897 | — | 4.179 | — | 100 | 100 | S 3° E | S 4° E |
| | 25 | | 1.990 | 2.267 | − 0.277 | 1.620 | — | 3.902 | — | 114 | 100 | S 5° E | S 6 E |
| | 26 | | 1,205 | 3.726 | − 2.521 | — | 0,901 | 1,381 | — | 100 | 100 | S | S 14° E |
| | 27 | | 2.115 | 1.185 | + 0.930 | 0.029 | — | 2.311 | — | 100 | 100 | S 17 E | S 7° E |
| | 28 | | 0,665 | 0.394 | + 0.271 | 0,300 | — | 2.582 | — | 100 | 100 | S 28° E | S 20° E |
| | 29 | | 1,040 | 0.685 | + 0 355 | 0.655 | — | 2,937 | — | 100 | 100 | S 34° E | S 7 E |
| | 30 | | 0,655 | 1.671 | − 1.016 | — | 0 361 | 1,921 | — | 115 | 100 | S 7° E | S 12 E |
| | 31 | | 1.775 | 0.045 | + 1.730 | 1,369 | — | 3.651 | — | 100 | 100 | S 15° E | S 12° E |
| | 32 | | 0 615 | 1.524 | − 0.909 | 0.460 | — | 2 742 | — | 100 | 100 | S 10 E | S 13° E |
| | 33 | | 0.955 | 0.296 | + 0.659 | 1,119 | — | 3.401 | — | 100 | 100 | S 10° E | S 12 E |
| | 34 | | 0,855 | 1.869 | − 1,014 | 0.105 | — | 2.387 | — | 100 | 100 | S 8° E | S 3° E |
| | 35 | | 1.508 | 1.563 | − 0.055 | 0.050 | — | 2 332 | — | 100 | 100 | S 4° E | S 10° E |
| | 36 | | 1.768 | 1.075 | + 0 693 | 0,743 | — | 3.025 | — | 100 | 100 | S 2 E | S |
| | 37 | | 0.835 | 0.925 | − 0 090 | 0.653 | — | 2.935 | — | 100 | 100 | S | S 1° E |
| | 38 | | 0.515 | 1.995 | − 1.480 | — | 0.827 | 1 455 | — | 100 | 100 | S | S 5 E |
| | 39 | | 3.336 | 1.735 | + 1.601 | 0,774 | — | 3.056 | — | 100 | 100 | S | S 4° E |
| | 40 | | 0,948 | 1.782 | − 0,834 | — | 0.060 | 2.222 | — | 100 | 100 | S 1 E | S 1° W |

| Camp. | Number of station. | Date | Back-wards. | For-wards. | Difference | Above starting point + | Below starting point — | Above surface of Kara-koschun. | Below surface of Kara-koschun | Distance in m. from staff to tube | Distance in m. from tube to staff. | Direction from staff to tube | Direction from tube to staff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| | 41 | 10 | 2,149 | 1,327 | + 0.822 | 0.762 | — | 3.044 | — | 100 | 100 | S 9° W | S 7° E |
| | 42 | | 0 466 | 0.553 | — 0.087 | 0.675 | — | 2,957 | — | 100 | 100 | S 3 E | S 33° W |
| | 43 | | 1.888 | 1,300 | + 0.588 | 1.263 | — | 3.545 | — | 125 | 100 | S 29 W | S 8° E |
| | 44 | | 1,625 | 0,685 | + 0,940 | 2,203 | — | 4.485 | — | 100 | 100 | S 5° W | S 1° E |
| CLX | 45 | | 0.595 | 2,995 | — 2.400 | — | 0,197 | 2.085 | — | 143 | 118 | S 9 E | S 15 E |
| | 46 | 12 | 2,437 | 0,968 | + 1,469 | 1.272 | — | 3.554 | — | 100 | 100 | S 11° E | S 17° E |
| | 47 | | 1,654 | 1,195 | + 0,459 | 1,731 | — | 4.013 | — | 100 | 100 | S 9 E | S 12° E |
| | 48 | | 1,198 | 2,628 | — 1,430 | 0,301 | — | 2,583 | — | 100 | 100 | S 10 E | S 10° E |
| | 49 | | 2,015 | 3,467 | — 1,452 | — | 1,151 | 1.131 | — | 100 | 100 | S 15 E | S 78° E |
| | 50 | | 2,897 | 3,389 | — 0,492 | — | 1.643 | 0,639 | — | 150 | 100 | S 9° E | S 49° E |
| | 51 | | 1,650 | 0,842 | + 0,808 | — | 0,835 | 1,447 | — | 100 | 100 | S 47° E | S 57° E |
| | 52 | | 2,647 | 0,536 | + 2,111 | 1.276 | — | 3.558 | — | 109 | 100 | S 26° E | S 8° E |
| | 53 | | 0,945 | 0,925 | + 0,020 | 1,296 | — | 3.578 | — | 100 | 100 | S 20° E | S 18° E |
| | 54 | | 1.222 | 2,162 | — 0.940 | 0.356 | — | 2,638 | — | 100 | 128 | S 11° E | S 17° E |
| | 55 | | 1,800 | 1,922 | — 0,122 | 0.234 | — | 2,516 | — | 100 | 100 | S 2° E | S 18° E |
| | 56 | | 1.132 | 0,308 | + 0,824 | 1,058 | — | 3.340 | — | 100 | 100 | S 20° E | S 35° E |
| | 57 | | 0,865 | 1,951 | — 1,086 | — | 0,028 | 2,254 | — | 120 | 100 | S 30° E | S 5° E |
| | 58 | | 1,065 | 0,455 | + 0,610 | 0.582 | — | 2,864 | — | 121 | 100 | S 14° E | S 23° E |
| | 59 | | 1,772 | 2,325 | — 0,553 | 0.029 | — | 2.311 | — | 106 | 100 | S 11° E | S 11° E |
| | 60 | | 0.538 | 2,075 | — 1.537 | — | 1.508 | 0.774 | — | 100 | 117 | S 8° E | S 8° E |
| | 61 | | 1,986 | 0,768 | + 1,218 | — | 0,290 | 1,992 | — | 114 | 100 | S 16° E | S 14° E |
| | 62 | | 1,640 | 0,966 | + 0,674 | 0,384 | — | 2,666 | — | 100 | 100 | S 15° E | S 7° E |
| | 63 | | 0,968 | 1,093 | — 0,125 | 0,259 | — | 2,541 | — | 108 | 100 | S 4° E | S 9° E |
| | 64 | | 0,887 | 1,409 | — 0,522 | — | 0,263 | 2.019 | — | 100 | 109 | S 11° E | S 8° E |
| | 65 | | 2,650 | 2,152 | + 0,498 | 0.235 | — | 2.517 | — | 100 | 118 | S 10° E | S 15° E |
| | 66 | | 2,378 | 2,133 | + 0,245 | 0,480 | — | 2.762 | — | 129 | 100 | S 5° E | S 3° W |
| | 67 | | 2,525 | 1,267 | + 1,258 | 1,738 | — | 4,020 | — | 121 | 100 | S | S 4° W |
| | 68 | | 0,810 | 2,950 | — 2,140 | — | 0,402 | 1.880 | — | 100 | 120 | S 3 W | S 16° E |
| | 69 | | 2,695 | 0,665 | + 2,030 | 1,628 | — | 3,910 | — | 152 | 130 | S 10 E | S 17° E |
| | 70 | | 1,239 | 1,925 | — 0,686 | 0,942 | — | 3.224 | — | 100 | 142 | S 1° E | S 6° E |
| | 71 | | 2,124 | 2,875 | — 0,751 | 0,191 | — | 2,473 | — | 119 | 100 | S 6 E | S 9° E |
| | 72 | | 1.708 | 0,470 | + 1,238 | 1.429 | — | 3.711 | — | 115 | 100 | S 3 E | S 2° E |
| | 73 | | 1,242 | 2,824 | — 1,582 | — | 0.153 | 2,129 | — | 100 | 100 | S 7° E | S 13 E |
| | 74 | | 2,408 | 1,235 | + 1,173 | 1,020 | — | 3,302 | — | 100 | 100 | S 11° E | S 13 E |
| | 75 | | 0,821 | 2,183 | — 1,362 | — | 0,342 | 1.940 | — | 116 | 100 | S 17° E | S 16 E |
| | 76 | | 1,635 | 1,590 | + 0,045 | — | 0,297 | 1,985 | — | 100 | 100 | S 13° E | S 6° E |
| | 77 | | 1,695 | 1,225 | + 0,470 | 0,173 | — | 2,455 | — | 140 | 100 | S | S 3° W |
| | 78 | | 2,850 | 1,077 | + 1,773 | 1,946 | — | 4,228 | — | 117 | 100 | S 3° E | S 19° E |
| | 79 | | 1.751 | 1,282 | + 0,469 | 2,415 | — | 4,697 | — | 100 | 100 | S 14° E | S 11° E |
| | 80 | | 0.731 | 2,959 | — 2,228 | 0,187 | — | 2,469 | — | 150 | 122 | S 47° E | S 17° E |

| Camp | Number of station. | Date. | Backwards | Forwards. | Difference. | Above starting point +. | Below starting point —. | Above surface of Kara-koschun | Below surface of Kara-koschun | Distance in m. from staff to tube | Distance in m. from tube to staff. | Direction from staff to tube. | Direction from tube to staff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 81 | March<br>12 | 0,150 | 3,860 | − 3.710 | — | 3.523 | — | 1.241 | 138 | 151 | S 15° E | S 32° E |
| | 82 | | 2.855 | 3.195 | − 0.340 | — | 3.863 | — | 1.581 | 115 | 100 | S 10° E | S 62° E |
| | 83 | | 2,165 | 2,273 | − 0.108 | — | 3,971 | — | 1.689 | 100 | 100 | S 22° E | S 68° E |
| | 84 | | 3,855 | 0,564 | + 3.291 | — | 0,680 | 1,602 | — | 126 | 100 | S 56° E | S 1° E |
| | 85 | | 1,095 | 1.534 | − 0.439 | — | 1.119 | 1,163 | — | 136 | 100 | S 4° W | S |
| | 86 | | 3.395 | 1.150 | + 2.245 | 1,126 | — | 3.408 | — | 107 | 100 | S 34° W | S 17° E |
| | 87 | | 1.595 | 2.151 | − 0.556 | 0,570 | — | 2,852 | — | 100 | 100 | S 13° E | S 15° E |
| | 88 | | 0,395 | 2,364 | − 1,969 | — | 1,399 | 0,883 | — | 109 | 100 | S 18° E | S 10° E |
| | 89 | | 2,146 | 2,172 | − 0,026 | — | 1.425 | 0,857 | — | 117 | 100 | S 3° E | S 1° E |
| | 90 | | 2.515 | 2.002 | + 0.513 | — | 0.912 | 1,370 | — | 114 | 141 | S 2° W | S 6° E |
| | 91 | | 2.114 | 2.344 | − 0.230 | — | 1,142 | 1,140 | — | 120 | 100 | S 4° W | S 14° E |
| | 92 | | 2,108 | 2,809 | − 0,701 | — | 1,843 | 0.439 | — | 150 | 100 | S | S 9° W |
| | 93 | | 0,081 | 1,190 | − 1,109 | — | 2,952 | — | 0.670 | 100 | 100 | S 6° W | S 11° W |
| | 94 | | 3.484 | 2,250 | + 1,234 | — | 1.718 | 0.564 | — | 100 | 154 | S 10° W | S 2° E |
| | 95 | | 0,360 | 1.513 | − 1,153 | — | 2,871 | — | 0.589 | 147 | 100 | S | S 4° E |
| CLXI | 96 | | 3.055 | 2,847 | + 0,208 | — | 2.663 | — | 0.381 | 103 | 100 | S 12° W | S 21° E |
| | 97 | 13 | 1.894 | 1.114 | + 0,780 | — | 1,883 | 0.399 | — | 100 | 100 | S 42° W | S 34° E |
| | 98 | | 0.270 | 2.178 | − 1.908 | — | 3.791 | — | 1.509 | 130 | 100 | S 14° E | S 1° W |
| | 99 | | 2.430 | 1.989 | + 0.441 | — | 3.350 | — | 1,068 | 100 | 100 | S 3° E | S 1° W |
| | 100 | | 2.472 | 0.929 | + 1,543 | — | 1.807 | 0 475 | — | 125 | 100 | S | S 8 W |
| | 101 | | 0,608 | 1.512 | − 0,904 | — | 2 711 | — | 0.429 | 165 | 100 | S 4° E | S 9° E |
| | 102 | | 1,632 | 0.881 | + 0,751 | — | 1,960 | 0.322 | — | 150 | 100 | S 1° E | S 1° E |
| | 103 | | 2,068 | 2.230 | − 0,162 | — | 2,122 | 0,160 | — | 100 | 129 | S | S 1° E |
| | 104 | | 2.935 | 1,352 | + 1,583 | — | 0.539 | 1.743 | — | 103 | 127 | S 1° E | S 3° E |
| | 105 | | 1,143 | 1.702 | − 0.559 | — | 1.098 | 1.184 | — | 105 | 100 | S 6° E | S 4° E |
| | 106 | | 1,132 | 2,955 | − 1,823 | — | 2.921 | — | 0.639 | 105 | 100 | S | S 1° E |
| | 107 | | 2,812 | 1,063 | + 1.749 | — | 1,172 | 1.110 | — | 130 | 114 | S 1° W | S 2 E |
| | 108 | | 2,716 | 2,817 | − 0.101 | — | 1.273 | 1.009 | — | 127 | 120 | S 3° W | S 6° W |
| | 109 | | 2,010 | 1,632 | + 0.378 | — | 0.895 | 1,387 | — | 100 | 100 | S 3° W | S |
| | 110 | | 1,649 | 2,225 | − 0.576 | — | 1.471 | 0,811 | — | 142 | 145 | S 7° W | S |
| | 111 | | 1,574 | 1,636 | − 0,062 | — | 1.533 | 0,749 | — | 104 | 100 | S 1° W | S |
| | 112 | | 1,829 | 1,670 | + 0,159 | — | 1.374 | 0.908 | — | 100 | 100 | S 6° E | S 3° E |
| | 113 | | 1,610 | 0,661 | + 0,949 | — | 0.425 | 1,857 | — | 112 | 100 | S 4° E | S 2° E |
| | 114 | | 1.389 | 1,615 | − 0,226 | — | 0.651 | 0,631 | — | 150 | 100 | S 3 W | S 12 W |
| | 115 | | 0,807 | 1.610 | − 0,803 | — | 1.454 | 0.828 | — | 100 | 100 | S 1° W | S 5° W |
| | 116 | | 0,415 | 0.925 | − 0.510 | — | 1.964 | 0.318 | — | 100 | 100 | S 3° W | S |
| | 117 | | 1,696 | 1.549 | + 0.147 | — | 1,817 | 0,465 | — | 100 | 100 | S | S |
| | 118 | | 1,965 | 1,624 | + 0.341 | — | 1.476 | 0,806 | — | 100 | 100 | S | S |
| | 119 | | 2,770 | 1,361 | + 1.409 | — | 0,067 | 2,215 | — | 100 | 100 | S 4 W | S 2° W |
| | 120 | | 0.474 | 2.489 | − 2,015 | — | 2.082 | 0.200 | — | 162 | 100 | S 6° W | S 6° W |

| Camp | Number of station | Date | Back-wards. | For-wards. | Difference | Above starting point — | Below starting point —. | Above surface of Kara-ko-chun. | Below surface of Kara-koschun | Distance in m. from staff to tube | Distance in m from tube to staff. | Direction from staff to tube | Direction from tube to staff. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| | 121 | 13 | 2,285 | 2,085 | + 0,200 | — | 1,882 | 0,400 | — | 100 | 100 | S | S |
| | 122 | | 1,982 | 0,693 | + 1,289 | — | 0,593 | 1,689 | — | 100 | 100 | S 1° E | S 6° E |
| | 123 | | 0,630 | 1,059 | − 0,429 | — | 1,022 | 1,260 | — | 109 | 100 | S | S |
| | 124 | | 1,425 | 3,355 | − 1,930 | — | 2,952 | — | 0,670 | 175 | 117 | S 16° E | S 11° E |
| | 125 | | 1,153 | 1,085 | + 0,068 | — | 2,884 | — | 0,602 | 121 | 100 | S 3° W | S |
| | 126 | | 2,196 | 1,072 | + 1,124 | — | 1,760 | 0,522 | — | 100 | 108 | S 1° E | S 8° E |
| | 127 | | 0,090 | 1,295 | − 1,205 | — | 2,965 | — | 0,683 | 119 | 100 | S | S |
| | 128 | | 3,860 | 3,888 | − 0,028 | — | 2,993 | — | 0,711 | 100 | 154 | S 7° W | S 4° W |
| | 129 | | 0,850 | 1,838 | − 0,988 | — | 3,981 | — | 1,699 | 168 | 100 | S 25° W | S 14° W |
| | 130 | | 2,808 | 2,765 | + 0,043 | — | 3,938 | — | 1,656 | 104 | 100 | S 1 E | S 23° W |
| | 131 | | 1,484 | 0,895 | + 0,589 | — | 3,349 | — | 1,067 | 100 | 100 | S 20 W | S 15° W |
| | 132 | | 3,411 | 1,401 | + 2,010 | — | 1,339 | 0,943 | — | 110 | 100 | S 28° W | S 5° W |
| | 133 | | 1,850 | 0,308 | + 1,542 | 0,203 | — | 2,485 | — | 145 | 103 | S 10° W | S 1° E |
| | 134 | | 0,986 | 3,488 | − 2,502 | — | 2,299 | — | 0,017 | 100 | 100 | S 3° E | S 10 E |
| | 135 | | 2,044 | 0,828 | + 1,216 | — | 1,083 | 1,199 | — | 117 | 100 | S 9° E | S 3° E |
| | 136 | | 1,945 | 2,536 | − 0,591 | — | 1,674 | 0,608 | — | 100 | 100 | S | S |
| | 137 | | 2,275 | 1 207 | + 1,068 | — | 0,606 | 1,676 | — | 150 | 100 | S 46° W | S 5° E |
| | 138 | | 1,488 | 1,416 | + 0,072 | — | 0,534 | 1,748 | — | 100 | 100 | S 5° E | S |
| | 139 | | 1,023 | 1,014 | + 0,009 | — | 0,525 | 1,757 | — | 125 | 100 | S | S 3° E |
| | 140 | | 1,268 | 1,553 | − 0,285 | — | 0,810 | 1,472 | — | 100 | 100 | S 3 E | S 3° E |
| | 141 | | 1,454 | 1,826 | − 0,372 | — | 1,182 | 1,100 | — | 100 | 100 | S 5° W | S 3° E |
| | 142 | | 2,105 | 1,587 | + 0,518 | — | 0,664 | 1,618 | — | 100 | 100 | S 1° W | S 1° E |
| | 143 | | 1,550 | 1,295 | + 0,255 | — | 0,409 | 1,873 | — | 100 | 100 | S | S 5° E |
| | 144 | | 1,667 | 1,994 | − 0,327 | — | 0,736 | 1,546 | — | 100 | 100 | S 1° E | S |
| | 145 | | 1,405 | 1,495 | − 0,090 | — | 0,826 | 1,456 | — | 100 | 100 | S | S |
| | 146 | | 1,532 | 1,855 | − 0,323 | — | 1,149 | 1,133 | — | 100 | 100 | S 5° W | S 9° W |
| | 147 | | 1,212 | 1,902 | − 0,690 | — | 1,839 | 0,443 | — | 115 | 100 | S 7° E | S 1° E |
| | 148 | | 3,162 | 1,525 | + 1,637 | — | 0,202 | 2,080 | — | 122 | 100 | S 4° E | S |
| | 149 | | 1,669 | 2,175 | − 0,506 | — | 0,708 | 1,574 | — | 100 | 100 | S 4° E | S 4° E |
| | 150 | | 2,047 | 0,955 | + 1,092 | 0,384 | — | 2,666 | — | 100 | 100 | S | S |
| | 151 | | 1,262 | 1,495 | − 0,233 | 0,151 | — | 2,433 | — | 100 | 100 | S 9 E | S 1 E |
| | 152 | | 1,275 | 1,352 | − 0,077 | 0,074 | — | 2,356 | — | 100 | 100 | S 2° E | S 1° E |
| | 153 | | 1,334 | 1,400 | − 0,066 | 0,008 | — | 2,290 | — | 100 | 100 | S 2 W | S 1° W |
| | 154 | | 1,426 | 1,345 | + 0,081 | 0,089 | — | 2,371 | — | 100 | 100 | S 5 E | S |
| | 155 | | 1,138 | 1,390 | − 0,252 | — | 0,163 | 2,119 | — | 100 | 100 | S 3 E | S |
| CLXII | 156 | | 1,636 | 1,373 | + 0,263 | 0,100 | — | 2,382 | — | 100 | 100 | S | S |
| | 157 | 14 | 0,955 | 1,029 | − 0,074 | 0,026 | — | 2,308 | — | 112,5 | 112,5 | S 2° W | S 2° E |
| | 158 | | 1,253 | 1,234 | + 0 019 | 0,045 | — | 2,327 | — | 112,5 | 112,5 | S 4° E | S 1 E |
| | 159 | | 1,262 | 1,351 | − 0,089 | — | 0,044 | 2,238 | — | 112,5 | 112,5 | S | S |
| | 160 | | 1,452 | 1,269 | + 0,183 | 0,130 | — | 2,421 | — | 112,5 | 112,5 | S 4 W | S 1 E |

| Camp | Number of station | Date | Backwards | Forwards | Difference | Above starting point + | Below starting point — | Above surface of Kara-koschun | Below surface of Kara-koschun | Distance in m from staff to tube. | Distance in m from tube to staff | Direction from staff to tube. | Direction from tube to staff. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 161 | March 14 | 1.368 | 1.374 | — 0.006 | 0.133 | — | 2.415 | — | 112.5 | 112.5 | S 2 E | S 6 E |
| | 162 | | 1.455 | 1.415 | + 0.040 | 0.173 | — | 2.455 | — | 112.5 | 112.5 | S 4 E | S 13 E |
| | 163 | | 1.330 | 1.312 | + 0.018 | 0.191 | — | 2.473 | — | 112.5 | 112.5 | S 7 E | S 5 E |
| | 164 | | 1.391 | 1.488 | — 0.097 | 0,094 | — | 2.376 | | 112.5 | 112.5 | S | S 2 E |
| | 165 | | 1.411 | 1.360 | + 0.051 | 0.145 | — | 2.427 | - | 112.5 | 112.5 | S 3 E | S 8 E |
| | 166 | | 1.209 | 1.151 | + 0.058 | 0.203 | — | 2.485 | — | 112.5 | 112.5 | S | S |
| | 167 | | 1.293 | 1.365 | — 0.072 | 0,131 | — | 2.413 | — | 112.5 | 112.5 | S | S 2 E |
| | 168 | | 1,062 | 1.357 | — 0.295 | — | 0.164 | 2.118 | — | 112.5 | 112.5 | S 3 E | S |
| | 169 | | 1.806 | 1.396 | + 0.410 | 0.246 | — | 2.528 | | 112.5 | 112.5 | S | S 1 E |
| | 170 | | 1.261 | 1.575 | — 0.314 | — | 0,068 | 2.214 | — | 112.5 | 112.5 | S 8 W | S |
| | 171 | | 1.712 | 1.384 | + 0.328 | 0.260 | — | 2.542 | — | 112.5 | 112.5 | S 15 W | S 7 E |
| | 172 | | 1.371 | 1.394 | — 0.023 | 0.237 | — | 2.519 | — | 112.5 | 112.5 | S | S 1 W |
| | 173 | | 1.297 | 1.274 | + 0.023 | 0.260 | — | 2.542 | — | 112.5 | 112.5 | S 2 W | S 4 W |
| | 174 | | 1.315 | 1.371 | — 0.056 | 0.204 | — | 2.486 | — | 112.5 | 112.5 | S 6 W | S 8 W |
| | 175 | | 1.305 | 1.362 | — 0.057 | 0.147 | — | 2.429 | — | 112.5 | 112.5 | S 8 W | S |
| | 176 | | 1.405 | 1.285 | + 0.120 | 0.267 | — | 2.549 | — | 112.5 | 112.5 | S 8 W | S 2 W |
| | 177 | | 1,265 | 0.618 | + 0.647 | 0.914 | — | 3.196 | — | 112.5 | 112.5 | S 7 W | S 5 E |
| | 178 | | 0.824 | 1.830 | — 1.006 | — | 0,092 | 2.190 | — | 112.5 | 112.5 | S 1 E | S |
| | 179 | | 1.555 | 1.229 | + 0.326 | 0.234 | — | 2.516 | — | 112.5 | 112.5 | S | S 1 E |
| | 180 | | 1.559 | 1.270 | + 0.289 | 0.523 | — | 2,805 | — | 112.5 | 112.5 | S 2 W | S |
| | 181 | | 1.236 | 1.395 | — 0.159 | 0.364 | — | 2.646 | — | 112.5 | 112.5 | S 5 W | S |
| | 182 | | 1.275 | 1.292 | — 0,017 | 0,347 | — | 2,629 | — | 112.5 | 112.5 | S 5° W | S 4 W |
| | 183 | | 1.384 | 1.310 | + 0.074 | 0.421 | — | 2.703 | — | 112.5 | 112.5 | S | S |
| | 184 | | 1,222 | 1.295 | — 0.073 | 0.348 | — | 2.630 | — | 112.5 | 112.5 | S 2 W | S 8 W |
| | 185 | | 1.450 | 1.425 | + 0.025 | 0.373 | | 2.655 | — | 112.5 | 112.5 | S 4 W | S 5° W |
| | 186 | | 1.307 | 1.425 | — 0.118 | 0.255 | — | 2.537 | — | 112.5 | 112.5 | S 4 W | S 9° W |
| | 187 | | 1.596 | 1.535 | + 0.061 | 0.316 | — | 2.598 | — | 112.5 | 112.5 | S 7 W | S 3 W |
| | 188 | | 1.562 | 1.511 | + 0.051 | 0.367 | — | 2.649 | — | 112.5 | 112.5 | S 2 W | S 3 W |
| | 189 | | 1.481 | 1.450 | + 0.031 | 0.398 | — | 2.680 | — | 112.5 | 112.5 | S 5° W | S 2 W |
| | 190 | | 1.488 | 1.420 | + 0,068 | 0.466 | — | 2.748 | — | 112.5 | 112.5 | S 1 W | S 2 W |
| | 191 | | 1.328 | 1.222 | + 0.106 | 0.572 | — | 2.854 | — | 112.5 | 112.5 | S 4 W | S 2 W |
| | 192 | | 1.298 | 1.463 | — 0.165 | 0.407 | — | 2.689 | — | 112.5 | 112.5 | S 5 W | S 1 W |
| | 193 | | 1.476 | 1.450 | + 0.026 | 0.433 | — | 2.715 | — | 112.5 | 112.5 | S 3 W | S 4 W |
| | 194 | | 1.415 | 1.335 | + 0.080 | 0.513 | — | 2.795 | — | 112.5 | 112.5 | S 2 W | S 2 W |
| | 195 | | 1,107 | 1.070 | + 0.037 | 0.550 | — | 2.832 | — | 112.5 | 112.5 | S 3 W | S |
| | 196 | | 1.355 | 1.413 | — 0.058 | 0.492 | — | 2.774 | — | 112.5 | 112.5 | S 1 W | S 1 W |
| | 197 | | 1.395 | 1.323 | + 0.072 | 0.564 | — | 2.846 | — | 112.5 | 112.5 | S 1 W | S 9 W |
| | 198 | | 1.347 | 1.298 | + 0.049 | 0.613 | — | 2.895 | — | 112.5 | 112.5 | S 7 W | S 4 W |
| | 199 | | 1.340 | 1.370 | — 0.030 | 0.583 | — | 2.865 | — | 112.5 | 112.5 | S 4 W | S 4 W |
| | 200 | | 1.196 | 1.212 | — 0.016 | 0.567 | — | 2.849 | — | 112.5 | 112.5 | S 5 W | S 9° W |

| Camp | Number of station | Date. | Backwards. | Forwards. | Difference. | Above starting point — | Below starting point — | Above surface of Kara-koschun | Below surface of Kara-koschun | Distance in m from staff to tube | Distance in m from tube to staff. | Direction from staff to tube | Direction from tube to staff. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| | 201 | 14 | 1,446 | 1,274 | + 0.172 | 0.739 | — | 3.021 | -- | 112,5 | 112.5 | S 3 W | S 1 W |
| | 202 | | 1.287 | 1.365 | — 0.078 | 0,661 | — | 2.943 | — | 112.5 | 112.5 | S | S 6 W |
| | 203 | | 1,615 | 1.660 | — 0.045 | 0.616 | — | 2.898 | — | 112.5 | 112.5 | S 2 W | S 4 W |
| | 204 | | 1.544 | 1.405 | + 0.139 | 0.755 | — | 3.037 | — | 112.5 | 112,5 | S 8 W | S 5 W |
| | 205 | | 1.300 | 1.215 | + 0.085 | 0.840 | — | 3.122 | — | 112.5 | 112.5 | S | S |
| CLXIII | 206 | | 1,211 | 1.307 | — 0.096 | 0.744 | — | 3.026 | — | 112.5 | 112,5 | S 5 W | S 3°W |
| | 207 | 15 | 1.414 | 1.435 | — 0.021 | 0.723 | — | 3.005 | — | 133 | 133 | S 1 W | S 2 W |
| | 208 | | 1.375 | 1.307 | + 0.068 | 0.791 | — | 3.073 | — | 133 | 133 | S 4 W | S 5 W |
| | 209 | | 1.352 | 1.369 | — 0.017 | 0.774 | — | 3,056 | — | 133 | 133 | S 2 W | S 3°W |
| | 210 | | 1,295 | 1.230 | + 0.065 | 0.839 | — | 3,121 | — | 133 | 133 | S 8°W | S 4 W |
| | 211 | | 1,284 | 1,287 | — 0.003 | 0,836 | — | 3,118 | — | 133 | 133 | S 11 W | S 5 W |
| | 212 | | 1,400 | 1,102 | + 0,298 | 1.134 | — | 3.416 | — | 133 | 133 | S 7°W | S 3°W |
| | 213 | | 1.128 | 1.528 | — 0.400 | 0.734 | — | 3,016 | — | 133 | 133 | S 12°W | S 10 W |
| | 214 | | 1.385 | 1,212 | + 0,173 | 0.907 | — | 3,189 | — | 133 | 133 | S 8 W | S 9°W |
| | 215 | | 1,341 | 1.415 | — 0.074 | 0,833 | — | 3.115 | — | 133 | 133 | S 9 W | S 13°W |
| | 216 | | 1.523 | 1.435 | + 0,088 | 0,921 | — | 3.203 | — | 133 | 133 | S 11°W | S 8°W |
| | 217 | | 1,355 | 1.345 | + 0.010 | 0.931 | — | 3.213 | — | 133 | 133 | S 11°W | S 4°W |
| | 218 | | 1,295 | 1,008 | + 0,287 | 1,218 | — | 3.500 | — | 133 | 133 | S 6°W | S 1°W |
| | 219 | | 1.111 | 1,396 | — 0,285 | 0.933 | — | 3.215 | — | 133 | 133 | S 10°W | S 11°W |
| | 220 | | 1.366 | 1.225 | + 0.141 | 1.074 | — | 3.356 | — | 133 | 133 | S 2°W | S 3°W |
| | 221 | | 1.284 | 1.419 | — 0.135 | 0,939 | — | 3,221 | — | 133 | 133 | S 6°W | S 3°W |
| | 222 | | 1,688 | 1.585 | + 0.103 | 1,042 | — | 3.324 | — | 133 | 133 | S 3 W | S |
| | 223 | | 1.375 | 1.275 | + 0.100 | 1,142 | — | 3.424 | — | 133 | 133 | S 3 W | S 13°W |
| | 224 | | 1.568 | 1.632 | — 0.064 | 1,078 | — | 3.360 | — | 133 | 133 | S 9°W | S 13°W |
| | 225 | | 1.445 | 1.445 | ± 0.000 | 1.078 | — | 3.360 | — | 133 | 133 | S 9°W | S 9°W |
| | 226 | | 1.335 | 1.285 | + 0.050 | 1,128 | — | 3.410 | — | 133 | 133 | S 6°W | S 15 W |
| | 227 | | 1.364 | 1.657 | — 0.293 | 0,835 | — | 3,117 | — | 133 | 133 | S 7 W | S 11 W |
| | 228 | | 1.498 | 1,065 | + 0.433 | 1.268 | — | 3.550 | — | 133 | 133 | S 13 W | S 23°W |
| | 229 | | 1,275 | 1.469 | — 0.194 | 1.074 | — | 3.356 | — | 133 | 133 | S 15°W | S 13°W |
| | 230 | | 1.490 | 1.285 | + 0,205 | 1.279 | — | 3.561 | — | 133 | 133 | S 14 W | S 13 W |
| | 231 | | 1.445 | 2,113 | — 0.668 | 0,611 | — | 2,893 | — | 133 | 133 | S 17 W | S 13 W |
| | 232 | | 1.914 | 1.110 | + 0.804 | 1.415 | — | 3.697 | — | 133 | 133 | S 15 W | S 15 W |
| | 233 | | 1.329 | 1,525 | — 0.196 | 1.219 | — | 3.501 | — | 133 | 133 | S 14 W | S 24 W |
| | 234 | | 1.515 | 1.524 | — 0.009 | 1.210 | — | 3.492 | — | 133 | 133 | S 20 W | S 17 W |
| | 235 | | 1,269 | 1.363 | — 0.094 | 1.116 | — | 3.398 | — | 133 | 133 | S 17 W | S 21 W |
| | 236 | | 1.405 | 1.536 | — 0.131 | 0.985 | — | 3,267 | — | 133 | 133 | S 28°W | S 20 W |
| | 237 | | 1.774 | 1.435 | + 0,339 | 1.324 | — | 3.606 | — | 133 | 133 | S 33 W | S 28 W |
| | 238 | | 1.362 | 1.514 | — 0,152 | 1.172 | — | 3.454 | — | 133 | 133 | S 31 W | S 29 W |
| | 239 | | 1.068 | 1.431 | — 0.363 | 0.809 | — | 3.091 | — | 133 | 133 | S 29 W | S 29 W |
| | 240 | | 1.745 | 1.530 | + 0.215 | 1.024 | — | 3.306 | — | 133 | 133 | S 34°W | S 30 W |

| Camp | Number of station | Date | Back-wards | For-wards | Difference | Above starting point + | Below starting point —. | Above surface of Kara-koschun | Below surface of Kara-koschun | Distance in m from staff to tube | Distance in m from tube to staff | Direction from staff to tube. | Direction from tube to staff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| | 241 | 15 | 1.097 | 2.096 | − 0.999 | 0.025 | — | 2.307 | — | 133 | 133 | S 27 W | S 29° W |
| | 242 | | 2.245 | 2.412 | − 0.167 | — | 0.142 | 2.140 | — | 133 | 133 | S 60° W | S 47 W |
| | 243 | | 1.442 | 1.273 | + 0.169 | 0.027 | — | 2.309 | — | 133 | 133 | S 33 W | S 19° W |
| | 244 | | 1.536 | 1.629 | − 0.093 | — | 0.066 | 2.216 | — | 133 | 133 | S 21 W | S 19 W |
| | 245 | | 1.699 | 1.105 | + 0.594 | 0.528 | — | 2.804 | — | 133 | 133 | S 15° W | S 19° W |
| | 246 | | 1.125 | 1.042 | + 0.083 | 0.611 | — | 2.893 | — | 133 | 133 | S 21° W | S 22 W |
| | 247 | | 2.068 | 2.370 | − 0.302 | 0.309 | — | 2.591 | — | 133 | 133 | S 23° W | S 17 W |
| | 248 | | 1.855 | 0.424 | + 1.431 | 1.740 | — | 4.022 | — | 133 | 133 | S 18° W | S 15° W |
| | 249 | | 1.084 | 2.325 | − 1.241 | 0.499 | — | 2.781 | — | 133 | 133 | S 19 W | S 22° W |
| | 250 | | 0.995 | 0.971 | + 0.024 | 0.523 | — | 2.805 | — | 133 | 133 | S 22° W | S 22° W |
| | 251 | | 1.275 | 1.165 | + 0.110 | 0.633 | — | 2.915 | — | 133 | 146 | S 33° W | S 28° W |
| | 252 | | 1.523 | 1.605 | − 0.082 | 0.551 | — | 2.833 | — | 133 | 133 | S 24° W | S 26 W |
| | 253 | | 1.576 | 1.355 | + 0.221 | 0.772 | — | 3.054 | — | 133 | 133 | S 19° W | S 20° W |
| | 254 | | 1.070 | 1.296 | − 0.226 | 0.546 | — | 2.828 | — | 133 | 133 | S 29 W | S 20° W |
| | 255 | | 2.048 | 2.136 | − 0.088 | 0.458 | — | 2.740 | — | 133 | 133 | S 15 W | S 15 W |
| | 256 | | 1.915 | 1.715 | + 0.200 | 0.658 | — | 2.940 | — | 133 | 133 | S 13° W | S 15 W |
| | 257 | | 1.062 | 1.185 | − 0.123 | 0.535 | — | 2.817 | — | 133 | 133 | S 20 W | S 13 W |
| | 258 | | 1.956 | 1.533 | + 0.423 | 0.958 | — | 3.240 | — | 133 | 133 | S 13 W | S 10 W |
| | 259 | | 1.399 | 1.066 | + 0.333 | 1.291 | — | 3.573 | — | 133 | 133 | S 12° W | S 15 W |
| | 260 | | 0.756 | 1.407 | − 0.651 | 0.640 | — | 2.922 | — | 133 | 133 | S 13 W | S 19° W |
| | 261 | | 1.766 | 1.410 | + 0.356 | 0.996 | — | 3.278 | — | 133 | 133 | S 9 W | S 13° W |
| | 262 | | 1.127 | 1.275 | − 0.148 | 0.848 | — | 3.130 | — | 133 | 133 | S 9° W | S 11° W |
| | 263 | | 1.435 | 1.988 | − 0.553 | 0.295 | — | 2.577 | — | 133 | 133 | S 9° W | S 9 W |
| | 264 | | 1.625 | 1.165 | + 0.460 | 0.755 | — | 3.037 | — | 133 | 133 | S 18° W | S 15 W |
| | 265 | | 1.287 | 0.551 | + 0.736 | 1.491 | — | 3.773 | — | 133 | 133 | S 14° W | S 16 W |
| | 266 | | 1.523 | 2.723 | − 1.200 | 0.291 | — | 2.573 | — | 133 | 133 | S 10 W | S 10° W |
| CLXIV | 267 | | 1.226 | 1.077 | + 0.149 | 0.440 | — | 2.722 | — | 133 | 133 | S 5 W | S 9 W |
| | 268 | 16 | 1.069 | 1.045 | + 0.024 | 0.464 | — | 2.746 | — | 131 | 131 | S | S 2° W |
| | 269 | | 1.357 | 1.508 | − 0.151 | 0.313 | — | 2.595 | — | 131 | 131 | S 3° W | S 1° W |
| | 270 | | 1.233 | 1.324 | − 0.091 | 0.222 | — | 2.504 | — | 131 | 131 | S 1° E | S 5° E |
| | 271 | | 1.393 | 1.661 | − 0.268 | — | 0.046 | 2.236 | — | 131 | 131 | S 11° E | S 4 E |
| | 272 | | 1.522 | 1.395 | + 0.127 | 0.081 | — | 2.363 | — | 131 | 131 | S 5° E | S 1° E |
| | 273 | | 1.497 | 1.308 | + 0.189 | 0.270 | — | 2.552 | — | 131 | 131 | S 3 E | S 1° E |
| | 274 | | 1.168 | 1.161 | + 0.007 | 0.277 | — | 2.559 | — | 131 | 131 | S 1 W | S |
| | 275 | | 1.686 | 1.650 | + 0.036 | 0.313 | — | 2.595 | — | 131 | 131 | S | S 4 E |
| | 276 | | 1.657 | 1.443 | + 0.214 | 0.527 | — | 2.809 | — | 131 | 131 | S 4 E | S 3 E |
| | 277 | | 1.211 | 1.349 | − 0.138 | 0.389 | — | 2.671 | — | 131 | 131 | S 1° E | S 2 E |
| | 278 | | 1.339 | 1.456 | − 0.117 | 0.272 | — | 2.554 | — | 131 | 131 | S 1 E | S 3 E |
| | 279 | | 1.787 | 1.369 | + 0.418 | 0.690 | — | 2.972 | — | 131 | 131 | S 8 E | S 5 E |
| | 280 | | 1.703 | 1.685 | + 0.018 | 0.708 | — | 2.990 | — | 131 | 131 | S | S 1 E |

| Camp | Number of station. | Date. | Back-wards. | For-wards | Difference. | Above starting point − | Below starting point — | Above surface of Kara-koschun. | Below surface of Kara-koschun | Distance in m from staff to tube | Distance in m. from tube to staff. | Direction from staff to tube. | Direction from tube to staff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| | 281 | 16 | 1,708 | 1,767 | − 0,059 | 0,649 | — | 2,931 | — | 131 | 131 | S 1 E | S |
| | 282 | | 1,408 | 0,378 | + 1,030 | 1,679 | — | 3,961 | — | 131 | 131 | S | S 6° E |
| | 283 | | 0.451 | 1,795 | − 1.344 | 0,335 | — | 2,617 | — | 131 | 131 | S 2° E | S |
| | 284 | | 1,236 | 1,855 | − 0,619 | — | 0,284 | 1,998 | — | 131 | 131 | S | S |
| | 285 | | 2,113 | 1,496 | + 0,617 | 0.333 | — | 2,615 | — | 131 | 131 | S | S 1° W |
| | 286 | | 1,058 | 1,016 | + 0,042 | 0.375 | — | 2,657 | — | 131 | 131 | S | S |
| | 287 | | 1,296 | 1,607 | − 0,311 | 0,064 | — | 2,346 | — | 131 | 131 | S | S 1° E |
| | 288 | | 1,346 | 1,254 | + 0,092 | 0,156 | — | 2,438 | — | 131 | 131 | S 1° E | S 3° E |
| | 289 | | 1,415 | 1,405 | + 0,010 | 0,166 | — | 2.448 | — | 131 | 131 | S 1° E | S |
| | 290 | | 1,300 | 1,305 | − 0,005 | 0,161 | — | 2.443 | — | 131 | 131 | S 2° W | S |
| | 291 | | 1,370 | 1,084 | + 0,286 | 0,447 | — | 2,729 | — | 131 | 131 | S 1° E | S 2° E |
| | 292 | | 1,465 | 1,735 | − 0,270 | 0,177 | — | 2.459 | — | 131 | 131 | S 2° W | S 3° W |
| | 293 | | 1,065 | 1,456 | − 0,391 | — | 0,214 | 2,068 | — | 131 | 131 | S | S 2 W |
| | 294 | | 1,395 | 1,955 | − 0,560 | — | 0,774 | 1,508 | — | 131 | 131 | S 8° W | S 9° W |
| | 295 | | 1,867 | 2,092 | − 0,225 | — | 0,999 | 1,283 | — | 131 | 131 | S 8 W | S 11° W |
| | 296 | | 2,114 | 1,352 | + 0,762 | — | 0,237 | 2,045 | — | 131 | 131 | S 8° W | S 14 W |
| | 297 | | 1,536 | 2,250 | − 0,714 | — | 0,951 | 1,331 | — | 131 | 131 | S 18° W | S 28° W |
| | 298 | | 1,615 | 1,962 | − 0,347 | — | 1,298 | 0,984 | — | 131 | 131 | S 33° W | S 21° W |
| | 299 | | 2,225 | 2,580 | − 0,355 | — | 1,653 | 0,629 | — | 131 | 131 | S 33 W | S 22° W |
| | 300 | | 2,065 | 1,690 | + 0,375 | — | 1,278 | 1,004 | — | 131 | 131 | S 33° W | S 32° W |
| | 301 | | 2,005 | 0,955 | + 1,050 | — | 0,228 | 2,054 | — | 169 | 131 | S 31° W | S 30° W |
| | 302 | | 1,506 | 1,825 | − 0,319 | — | 0,547 | 1,735 | — | 131 | 131 | S 34° W | S 34° W |
| | 303 | | 2,095 | 1,829 | + 0,266 | — | 0,281 | 2,001 | — | 131 | 131 | S 35° W | S 16 W |
| | 304 | | 1,285 | 1,251 | + 0,034 | — | 0,247 | 1 035 | — | 131 | 131 | S 16° W | S 20° W |
| | 305 | | 1,251 | 1,667 | − 0,416 | — | 0,663 | 1,619 | — | 131 | 131 | S 8 W | S 12 W |
| | 306 | | 1,165 | 1,402 | − 0,237 | — | 0,900 | 1,382 | — | 131 | 131 | S 8° W | S 7° W |
| | 307 | | 1,269 | 1,135 | + 0,134 | — | 0,766 | 1,516 | — | 131 | 131 | S | S 4° W |
| | 308 | | 1,099 | 0,964 | + 0,135 | — | 0,631 | 1,651 | — | 131 | 131 | S 6° W | S 4° W |
| | 309 | | 2,075 | 1,155 | + 0,920 | 0,289 | — | 2 571 | — | 131 | 131 | S 3° W | S 3° W |
| | 310 | | 0,335 | 1,275 | − 0,940 | — | 0,651 | 1,631 | — | 131 | 131 | S 3° W | S |
| | 311 | | 0,867 | 1,705 | − 0,838 | — | 1,489 | 0,793 | — | 142 | 131 | S 1° W | S 3° W |
| | 312 | | 1,705 | 0,795 | + 0,910 | — | 0,579 | 1,703 | — | 131 | 131 | S 3 W | S 4° E |
| | 313 | | 1,445 | 1,150 | + 0,295 | — | 0,284 | 1,998 | — | 131 | 131 | S 2° E | S 2 E |
| | 314 | | 0,726 | 0,998 | − 0,272 | — | 0,556 | 1,726 | — | 131 | 131 | S 3° W | S 11° E |
| | 315 | | 0,770 | 1,155 | − 0,385 | — | 0,941 | 1,341 | — | 131 | 131 | S 4° E | S 7 E |
| | 316 | | 1,225 | 1,795 | − 0,570 | — | 1,511 | 0,771 | — | 131 | 131 | S 3 E | S 1 E |
| | 317 | | 1,245 | 1,124 | + 0,121 | — | 1,390 | 0,892 | — | 131 | 131 | S | S 2 E |
| | 318 | | 2,125 | 1,474 | + 0,651 | — | 0,739 | 1,543 | — | 131 | 131 | S | S |
| | 319 | | 0,675 | 1,429 | − 0,754 | — | 1,493 | 0,789 | — | 131 | 131 | S 2° E | S 2° E |
| | 320 | | 1,576 | 1,755 | − 0,179 | — | 1,672 | 0,610 | — | 113 | 131 | S 2° E | S 1 E |

| Camp. | Number of station | Date. | Backwards | Forwards | Difference | Above starting point +. | Below starting point — | Above surface of Kara-koschun | Below surface of Kara-koschun | Distance in m. from staff to tube. | Distance in m from tube to staff. | Direction from staff to tube | Direction from tube to staff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | March | | | | | | | | | | | |
| | 321 | 16 | 1,483 | 1,426 | + 0,057 | — | 1,615 | 0.667 | — | 131 | 131 | S | S 1° E |
| | 322 | | 1.274 | 1.315 | — 0.041 | — | 1,656 | 0,626 | — | 131 | 131 | S 5° E | S 4 E |
| | 323 | | 1,336 | 1,399 | — 0.063 | — | 1.719 | 0.563 | — | 131 | 131 | S 4 E | S 5 E |
| | 324 | | 1.305 | 1.268 | + 0.037 | — | 1.682 | 0.600 | — | 131 | 131 | S 4° E | S 3° E |
| | 325 | | 1.275 | 1.275 | ± 0.000 | — | 0,000 | 2.282 | — | 131 | 131 | S 4° E | S 1° E |
| | 326 | | 1.296 | 1,345 | — 0.049 | — | 1,731 | 0.551 | — | 131 | 131 | S 3 E | S 2° E |
| | 327 | | 1,362 | 1,304 | + 0.058 | — | 1,673 | 0.609 | — | 131 | 131 | S 1° E | S |
| | 328 | | 1,267 | 1,326 | — 0.059 | — | 1,732 | 0.550 | — | 131 | 131 | S 13° E | S 28° E |
| CLXV | 329 | 17 | 1.424 | 1,296 | + 0,128 | — | 1,604 | 0.678 | — | 131 | 131 | S 29 W | S 30° W |
| | 330 | | 2.325 | 1,699 | + 0.626 | — | 0,978 | 1,304 | — | 141 | 141 | S 40° W | S 36° W |
| | 331 | | 1.325 | 0.833 | + 0.492 | — | 0,486 | 1.796 | — | 141 | 141 | S 31 W | S 31 W |
| | 332 | | 1,015 | 1.335 | — 0.320 | — | 0.806 | 1,476 | — | 141 | 141 | S 39 W | S 39° W |
| | 333 | | 1.067 | 1.362 | — 0.295 | — | 1,101 | 1,181 | — | 141 | 141 | S 42° W | S 39° W |
| | 334 | | 1.086 | 1,690 | — 0.604 | — | 1.705 | 0,577 | — | 141 | 141 | S 37° W | S 33 W |
| | 335 | | 1.255 | 1.347 | — 0,092 | — | 1,797 | 0.485 | — | 141 | 141 | S 35° W | S 30 W |
| | 336 | | 1.323 | 1.286 | + 0.037 | — | 1.760 | 0.522 | — | 141 | 141 | S 40 W | S 41° W |
| | 337 | | 1,744 | 1.357 | + 0.387 | — | 1.373 | 0.909 | — | 141 | 141 | S 42° W | S 37° W |
| | 338 | | 2.726 | 1,276 | + 1.450 | 0.077 | — | 2.359 | — | 141 | 141 | S 41° W | S 37° W |
| | 339 | | 0,486 | 0,183 | + 0.303 | 0,380 | — | 2.662 | — | 141 | 141 | S 42 W | S 37 W |
| | 340 | | 1,084 | 1.814 | — 0,730 | — | 0.350 | 1.932 | — | 141 | 141 | S 37 W | S 34 W |
| | 341 | | 1,123 | 1,468 | — 0.345 | — | 0.695 | 1.587 | — | 141 | 141 | S 22 W | S 27° W |
| | 342 | | 1,076 | 1,005 | + 0.071 | — | 0.624 | 1,658 | — | 141 | 141 | S 23° W | S 12° W |
| | 343 | | 0.563 | 1,488 | — 0,925 | — | 1.549 | 0.773 | — | 141 | 141 | S 4 W | S 6° E |
| | 344 | | 1.304 | 0,926 | + 0.378 | — | 1.171 | 1.111 | — | 141 | 141 | S 4° E | S 6° E |
| | 345 | | 0,484 | 1,525 | — 1.041 | — | 2.212 | 0.070 | — | 141 | 141 | S 4° E | S 9 E |
| CLXVI | 346 | | 1.405 | 1,475 | — 0.070 | — | 2.282 | 0.000 | 0.000 | 141 | 141 | S 9° E | S 49 W |

The subjoined table gives the results of each of the seven days, distance travelled, rise or fall, and difference in meters. It shows at once that the surface was more irregular during the first three days than it was during the last four. The irregularity, which amounted, for instance, on 10th March to a rise of 17.2 m. and a fall of 17.4 m., is caused entirely by the jardangs; whereas on 14th March the surface was so extraordinarily level that for a distance of more than 11 km. we ascended only 3.588 m. and descended only 2.944 m.

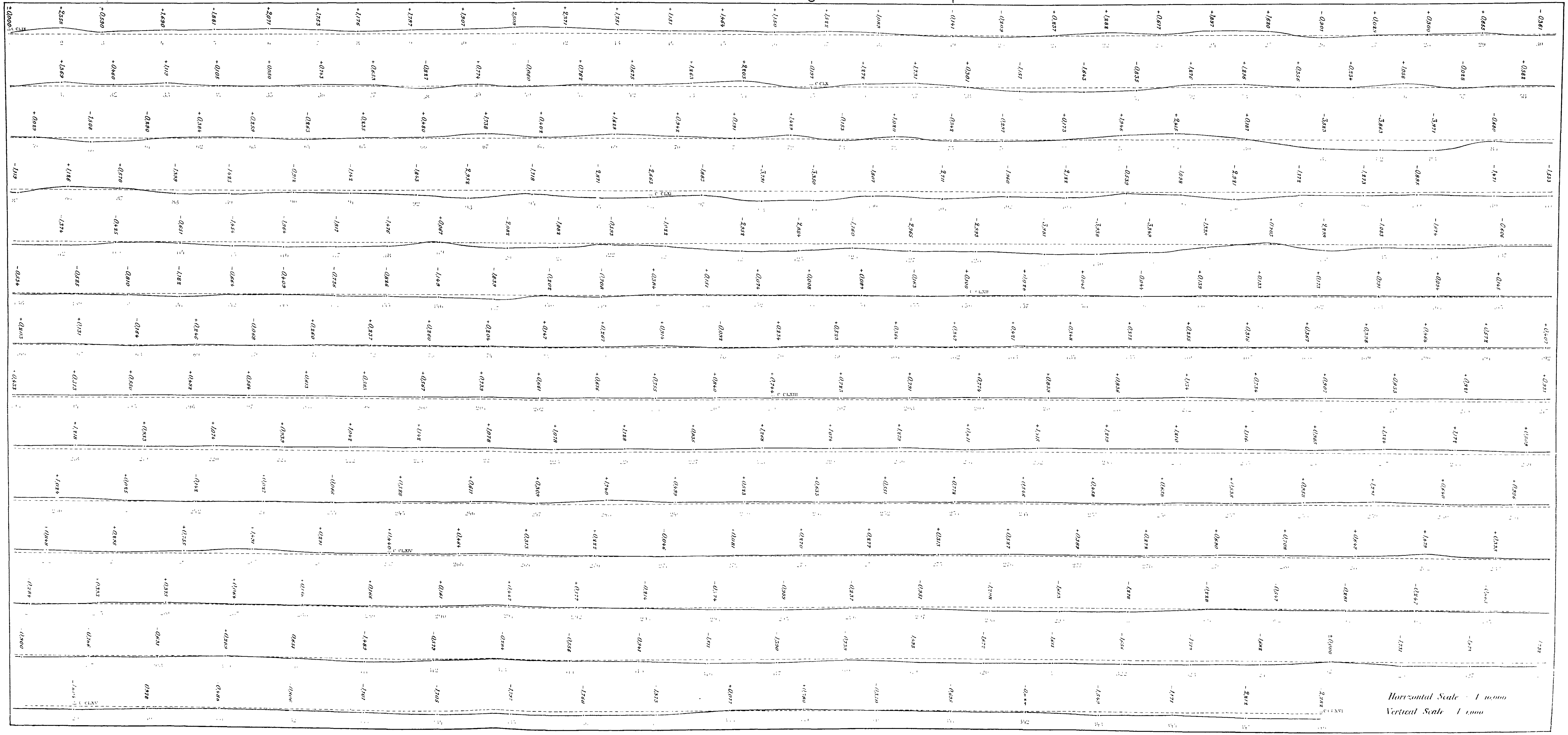
| Day | Distance travelled in m | Rise in m. | Fall in m. | Difference in m. |
|---|---|---|---|---|
| 10 March to Camp CLX . . . . . | 9,140 | + 17.217 | — 17.414 | — 0.197 |
| 12 March to Camp CLXI . . . . | 11,201 | + 24.883 | — 27.349 | — 2.466 |
| 13 March to Camp CLXII . . . . | 13,007 | + 23.306 | — 20.543 | + 2.763 |
| 14 March to Camp CLXIII . . . . | 11,250 | + 3.588 | — 2.844 | + 0.744 |
| 15 March to Camp CLXIV . . . . | 16,230 | + 8.668 | — 8.972 | — 0.304 |
| 16 March to Camp CLXV . . . . | 16,271 | + 7.915 | — 10.087 | — 2.172 |
| 17 March to Camp CLXVI . . . . | 4,794 | + 3.872 | — 4.422 | — 0.550 |

I have already said that I tested my instrument at Altmisch-bulak, and that a measured circle of 2756 m. gave a result of - 0.001 instead of ± 0.000. As it was impossible to determine the source of this error, whether it was due to the instrument, to the management of the staff, or to the taking of the readings, I have not used it as a corrective of the figures in the above table; but even if it were an instrumental error, it is so insignificant that it neither affects the contourline, nor the result and object of the survey, which was to prove or disprove the presence of a depression in the northern part of the desert.

I am perfectly well aware, that a survey such as this, that is not controlled in any way either by fixed points determined beforehand or by a return to the point of departure, whereby one might distribute over the entire distance any error there might be — I am well aware that such a survey does not possess full scientific value. But as a rigidly scientific survey would have demanded not only more men, camels, and provisions than I possessed, but also time which I could not spare, the results I have obtained must pass for what they are worth until we are somehow possessed of better; and I will venture to express the hope, that if I am not myself permitted to carry out a more perfect survey, I may at least direct somebody else to do it on my behalf, that is to say a complete survey of the Desert of Lop, coupled at the same time with a fresh examination of the changes which are now taking place, and will take place in the immediate future, in the distribution of the water there.

Meanwhile, with the view of counterbalancing to some extent the weaknesses inherent in a single line of traverse, every possible care and precaution were taken, as I have already observed, and I place the fullest confidence in the accuracy of my survey, partly because of the pains taken, partly because of the experience I had already had at home in similar work, and partly, and this especially, because of the movements which we ourselves saw were taking place in the Kara-koschun. If therefore it should occur to any one to object, that the value 2.282 m., as the difference of altitude between the point of departure and the Kara-koschun, is probably too little, since it may be assumed that the staff at each turn sank in a trifle, and that this after 344 turns would amount to a considerable figure, I would reply, first, that the staff was handled with the utmost care, and, secondly, that if there is any error, it should run in the opposite direction, that is to say, the value 2.282 m. is rather too high, and the difference of elevation between the point of departure and the end of the traverse is more likely less than 2.282 m. than greater. And for this no other proof is required beyond the simple fact, that a few kilometers west of our

# The measured line through the Desert of Lop.



Fotolit Gen Stab [illegible]

line of traverse the water was flowing towards the north and north-east, and consequently the surface there inclined in the opposite direction to what it did along our measured line. The contradiction is however only apparent, and I will explain it presently. It proves at all events, that the result I obtained, — 2.282 m., cannot well be too small, but may rather be too great.

The measured line amounts to 81.902 km., and on the whole runs north and south. In the course of that distance the elevation of 346 stations was determined. As I have already said, for the greater part of the way the distance between the staff and the telescope amounted to 100 m., except where the jardangs compelled us either to lengthen it or shorten it; for the latter part of the traverse however the distance was greater, so that the average for the entire journey works out at 118 m.

On the accompanying section (Plate 36) all the 346 stations are shown, together with their respective altitudes relatively to the point of departure at Lóu-lan; but the vertical values are multiplied by 20. Had the true scale been preserved, and the vertical values been given their proper proportions relative to the distance, the sectional line would, at all events to the eye, have been straight, and no depression would have been shown. An idea of the unparalleled flatness of the Desert of Lop, as well as of the unprecedented uniformity with which the surface keeps to the horizontal, may be obtained by imagining the 8.19 m. sectional line of the plate to be prolonged ten times, until it amounts to 81.9 m., the altitudes being preserved as they are now, so as to be strictly proportional to the length. The difference in altitude between the highest station and the lowest throughout the whole of this 81.9 m. long line would not be more than 6.49 mm., and, as I said before, the line would appear virtually straight. The occurrence of so extensive an area as this, with an almost horizontal position, in the heart of a continent may be described as something extremely unusual. Perfectly horizontal lines are characteristic of coasts and sea-shores, but here we have almost the same thing in the middle of Asia; that is to say, a line which in 81.902 km. does not fall more than 2.282 m., equivalent to 2.79 cm. in 1000 m. or 2.79 mm. in 100 m. But the thing that is of special interest is not this fall, which is evenly distributed throughout the whole of the line: it is more remarkable that at a distance of only 1862 m. from the shore of the Kara-koschun we were only 0.380 m. above our point of departure, so that, to adopt the terms we have just used, we may speak of a rise of 0.380 m. in 80.040 km. But the station at which this occurs is 2.662 m. above the level of the Kara-koschun. Hence, if the lake were to rise only 2.662 m. above its existing level, pretty nearly one-half of our measured line would be under water, and our point of departure at Lóu-lan would be covered with water to the depth of 38 cm. In the region immediately west of our survey the conditions are quite different: there no rise of the lake's surface is called for, because the desert is already under water.

It is even more remarkable that, in the northern part of the desert, along the line I surveyed, there are a whole series of stations that lie below the then existing level of the Kara-koschun. These stations are enumerated below:

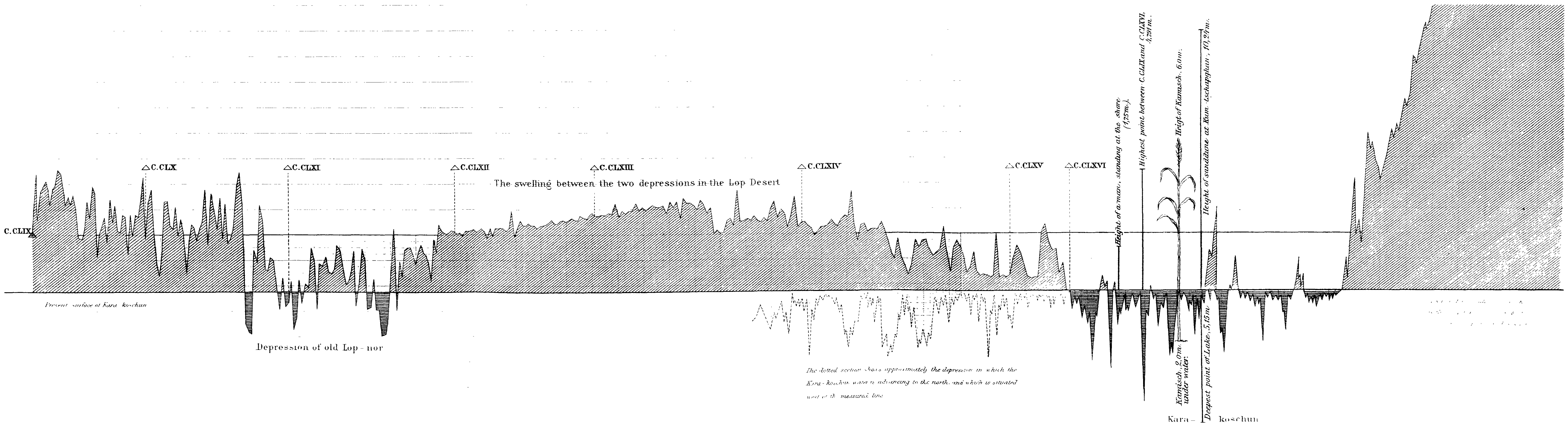
| No. of Point. | M. below Starting-Point. | M. below Level of Kara-koschun. |
|---|---|---|
| 81 | 3.523 | 1.241 |
| 82 | 3.863 | 1.581 |
| 83 | 3.971 | 1.689 |
| 93 | 2.952 | 0.670 |
| 95 | 2.871 | 0.589 |
| 96 | 2.663 | 0.381 |
| 98 | 3.791 | 1.509 |
| 99 | 3.350 | 1.068 |
| 101 | 2.711 | 0.429 |
| 106 | 2.921 | 0.639 |
| 124 | 2.952 | 0.670 |
| 125 | 2.884 | 0.602 |
| 127 | 2.965 | 0.683 |
| 128 | 2.993 | 0.711 |
| 129 | 3.981 | 1.699 |
| 130 | 3.938 | 1.656 |
| 131 | 3.349 | 1.067 |
| 134 | 2.299 | 0.017 |

From this table, as well as from the sections, it appears that all these stations occur in the same neighbourhood, a part of the desert moreover which comes immediately south of Lôu-lan, where, according to the Chinese maps, the bed of the Lop-nor was situated. The mean value of the last column is 0.939 m., so that, taking the average, the 18 stations quoted lie approximately 1 m. below the level of the Kara-koschun. If we possessed the results of several similar surveyed lines across this depression, we should be in a position to draw an isobathic map of the dry basin of the Lop-nor, and so get a picture of its cavity, showing the extent to which it has been excavated by the wind. The mean value just quoted is almost the same as that which we found to be the mean depth of the Kara-koschun in the beginning of April 1900, namely 0.81 m.

The distance between stations No. 81 and No. 134 amounts to 11,617 m., and along this stretch there are in all 54 stations, and of these 54 stations 51 lie below the starting-point and 18 below the Kara-koschun. It is however impossible to say how great a portion of the line lies below the level of the lake. If however we assume that the proportion between the number of intervals of distance (53) and the 18 stations is the same as that between 11,617 m. and $x$, then $x = 3945$ m. In round numbers it may be said that a distance of 4 km. lies below the level of the Kara-koschun, and if a canal were to be cut between the two, those 4 km. would be covered with water. The remainder of the distance, or 7.6 km., would rise above the surface of the lake, though nowhere more than 3.408 m., which is precisely half as high as the tallest kamisch rises above the water-level of the Kara-koschun. Taking the mean of all the 36 stations which in the northern depression lie above the level of the Kara-koschun (i. e. the stations between No. 81 and No. 134), the stretch of 7.6 km. would lie 1.143 m. above the lake; and it is only a question of time how soon this really small layer of clay will be planed away by the wind.

# Profile of the measured line through the Desert of Lop. The vertical scale is 2000 times greater than the horizontal scale.

*Vertical scale = 1:100 Horizontal scale = 1:200,000*



*The dotted section shows approximately the depression in which the Kara-koschun water is advancing to the north and which is situated west of the measured line*

The first seventeen stations lie higher than our starting-point, No. 1, which we fixed at Camp CLIX. Then follows a stretch which is sometimes above, sometimes below, No. 1, though mostly above it. At Camp CLX the staff was 0.197 m. below station No. 1, indicating a fall of barely 2 dm. in a distance of 9140 m. Between station No. 81 and No. 134 there are only three points that lie higher than the starting-point. The interval between No 135 to No. 149 also lies below the starting-point. Next follows a stretch of extraordinary flatness. Camp CLXII lies 0.100 m. above station No. 1, and Camp CLXIII 0.744 m. above the same; so that between these two stations, a distance of 13.007 m., there is a rise of 0.644 m. Of the 51 stations only 4 lie below the starting-point, and the amount is very small, 0.164 m. at the most. This stretch of the route brings us up to the crown of the scarce perceptible swelling, situated, at its highest, 1.415 m. above the point of departure. From this culminating point, barely the height of a man, the surface falls away towards Camp CLXIV, which lies 0.440 m. above station No. 1. While the ascent up to the culminating point of the swelling which separates these two desert lake-depressions is extraordinarily uniform, the descent to the south, towards the Kara-koschun, is far less uniform; and both the difference of slope and the difference of 2 m. elevation in a few hundred meters of distance begin immediately south of the swelling, and continue down to the shore of the lake. Although the sectional line undulates in waves, the general fall is nevertheless quite perceptible. At Camp CLXV the staff was 1.732 m. below station No. 1 and 0.550 m. above the Kara-koschun.

The accompanying section (see Plate 37) shows with especial clearness and distinctness not only both the depressions of the Desert of Lop, but also the swelling between them. It is only by exaggerating the vertical scale in this extraordinary way that the differences of level at the different stations can be made evident to the eye. Here the vertical scale is exaggerated 2000 times, that is to say, the 41 cm. long projection would have to be repeated 2000 times before it attained its natural dimensions in relation to the heights here shown; or in other words, if the vertical scale I have employed be retained, the base-line would have to be extended to a length of 819 m., or very little short of a kilometer. In spite of its preposterous dimensions, our plate does give a connected general view of the surface-relations of the desert. First we have Camp CLIX, a purely arbitrary point, where the surface has been excavated by the wind. This is evident from the fact that the houses of Lôu-lan stand upon pediments of clay 2 to 3 m. high, which have, of course, been formed since the old lake of Lop-nor disappeared. Camps CLX and CLXI lie lower than the first camp, but the three succeeding camps lie above it and indicate the flat step at the threshold of the swelling. Camps CLXV and CLXVI lie lower than the first and belong to the depression of the Kara-koschun. The lowest of all is Camp CLXI, 0.381 m. below the level of even the Kara-koschun; it is situated in the middle of the Lop-nor depression

The similarity between the parts of the surveyed line that come north of the old Lop-nor and those north of the Kara-koschun is at once very striking. The irregularities of the surface there are considerably greater than they are south of the two lakes in question. But it should be observed, that, while the tract north of the Kara-koschun has not any other noteworthy hollows or elevations except those shown in the sections, the region north of the Lop-nor is forty times more broken and irregular, each interval of 100 m. between staff and telescope crossing over a number of jardangs and wind-eroded gullies, which are not shown at all in the section (see fig. 148 above). Even on the greater section (Pl. 36) all these irregularities do not find a place, and even if the horizontal scale of the section were to be prolonged twenty times, the jardangs would still lie quite close together.

The dissimilarity between the northern and the southern slopes of the swelling becomes therefore all the more pronounced, the former being very much flatter than the latter. The entire surface there consists of schor, once covered by a salt lake. The northern slope belonged at a later date to the basin of the Lop-nor, the southern at a still later date to the basin of the Kara-koschun. Possibly the greater arching of the latter may be due to the more recent desiccation and the accompanying process of expansion, while the slightness of effect which the wind produces upon a schor surface as compared with a clay surface may have helped to make the Lop-nor slope flatter than the Kara-koschun slope.

The greatest inclination along the whole line occurs between station No. 79 and station No. 81, namely 5.938 m. in a distance of only 400 m. Hence along this stretch the difference of elevation is two to three times greater than that between the terminal points of the whole surveyed line.

I have made my Plate (37) also embrace the Kara-koschun, although its basin, in contrast to that of the Lop-nor, is absolutely unexplored in this meridian. The representation I have given therefore in the transverse section of the lake does not claim to be anything more than approximately correct. I have assumed its breadth to be 25 km., while I have taken the conditions of depth as being about the same as they are in the quarter where the river-arms A—F flow out of the lake. Hence my section shows a maximum depth of 4.4 m. But I hasten to say, it is extremely unlikely that such a considerable depth as this occurs anywhere in this eastern part of the Kara-koschun. We did sound that depth, it is true, in the arm C, but not only does C lie a good deal farther to the west, in a district better protected against the drift-sand, but the sounding was taken in a spot that had been excavated by an eddy. It is very likely that the deepest hollows in this part of the Kara-koschun are not deeper than the deepest hollows of the Lop-nor, i. e. 1.689, 1.509, and 1.699 m. below the level of the Kara-koschun at stations No. 83, No. 98, and No. 129. It is also conceivable that a considerably greater part of the breadth (25 km.) than what I have shown in the section consists of dry land. And, last but not least, it is very probable that the breadth of the Kara-koschun on this meridian is not greater than that of the Lop-nor, or 11 to 12 kilometers, although I have taken 25 km. as the average breadth of the Kara-koschun.

I have also entered on the section several other measurements for comparison. At 8½ cm. (on the Plate) from the southern shore of the Kara-koschun we already reach the 200 m. line above the lake; hence on the section it ought properly to lie 2 m. above the line which marks the surface of the Kara-koschun. This shows plainly the extraordinary difference in the slope north and south of the lake. The deepest sounding taken in the Kara-koschun, 5.150 m., is rather more than the highest point on the surveyed line, 4.791 m. The highest point on the shore of the Kara-koschun is the plant-bound sand-dune at Kum-tschapghan, namely 10.24 m. The longest reeds I measured in 1896 rose 6 m. above the water-level and descended 2 m. below it. Hence this extraordinarily vigorous and luxuriant kamisch, to which we found it impossible to force a passage in 1900 — its stalks were 6 cm. in circumference at the water-level — towered up more than one meter above the culminating point of the surveyed line and 3.718 m. above the point of departure. This circumstance again, that, throughout the distance of 81.9 km., we were never higher than the seed-vessels of this kamisch as it swayed in the wind in the marsh of the Kara-koschun, — this circumstance again is well calculated to convey a clear idea of the unparalleled flatness of the country. Finally I have indicated the height of a man standing on the shore, 1.75 m.; a loaded camel, on the other hand, would with the top of his burden reach up to the horizontal level of the point of departure.

A rise of 2.282 m. in the water-level of the Kara-koschun would cause this lake to expand to an extraordinary extent; but along the line we measured it would not lead to any communication with the Lop-nor basin, though if communication were established, this lake would become a lake of considerable size. Undoubtedly communication was at that time already established between the two depressions west of our line of traverse; this was owing to the formation of the new lakes originated by the arms A to F, which in 1901 had by no means reached their most northerly point, but were still moving steadily on in the direction of the Lop-nor depression. Sooner or later they will fill it, unless there happens to be a threshold or ridge west of Camps CLXII and CLXIII. But this is little likely, for in 1900 we crossed depressions in the Lop-basin which were filled with sand, and which were quite distinguishable without the aid of instruments.

# CHAPTER XXIII.

## GENERAL HYDROGRAPHICAL RELATIONS OF THE TARIM DELTAIC REGION.

Before proceeding to inquire into the cause of this remarkable horizontality, which, covering as it does such a large area in the middle of Asia, may be regarded as an exceptional circumstance, I will for a moment call attention to another question connected with the Lop-nor problem. In 1896, whilst travelling along the eastern bank of the Ilek, Avullu-köl, Kara-köl, etc., as far as Kum-tscheke, I could not help observing, that the Ilek flowed towards the east-south-east, while the chain of lakes from Avullu-köl downwards stretched towards the south-south-east, so that in this

Fig. 157. THE ILEK AT KUM-TSCHEKE IN 1896.

way the two dominant directions make a very distinct angle, the apex of which is precisely at the spot where the river empties itself into the Avullu-köl. At that time my knowledge of the country and of the relief of the deserts in the vicinity was much too limited, and I now find that the theory which I then put forward, partly with the view of explaining the origin of the angle itself, and partly for the purpose of establishing a connection between the old Lop-nor and this eastern chain of lakes, was incorrect, or at any rate can only be accepted as partially correct. True, it agreed with the observations I made later, that the Ilek, in virtue of its current and its power of undermining its banks, may preserve its position for several years, while the chain of lakes will be compelled by the advancing drift-sand to shift their positions to the west, or at all events their eastern shores must advance in that direction. On the other hand it was quite an error to look upon the Kara-köl and its neighbour lakes as a last lingering remnant of the Lop-nor, which have been pushed thus far west in consequence of the sand-storms being reduced to a minimum. For, as I have proved above, it was the Kuruk-darja which emptied itself into the lake of Lop-nor. I was also led to the conclusion, that the desert is gaining ground at the cost of the Kara-köl lakes, by the following facts, — the sand-dunes reach their greatest height close to their shores; several of the sand-dunes form peninsulas, projecting like capes and tongues out into the lake towards the west-south-west; immediately east of the lakes there are numerous pools and lagoons, which, though now cut off from the lakes, were formerly integral parts of the same; the forest exhibits various stages of maturity, proving that it has travelled westwards at the same rate as the lakes have done. On the other hand these facts failed to suggest the extent to which the lakes in question formerly stretched to the east, nor indeed can a definite answer be given to this question until after the desert between the Kara-köl lakes and the old Lop-nor has been thoroughly surveyed.

I have just said, that the theory I suggested in 1896 can only be in part correct. It is to a certain extent corroborated by the existence of the trench running from west-south-west to east-north-east, and containing all the great depths — Markat, Ilek, Tajek-köl, and Lop-nor. In one of the sections belonging to the hypsometrical resume at the end of this volume, I have inserted a depression which probably exists between the Tajek-köl and the Lop-nor. But how far the Kara-köl lakes really were connected with the Lop-nor, and especially with that part of it which we crossed in making our survey, it is at the present time impossible to say. As however I have supposed, that west and west-south-west of stations Nos. 81, 82 and 83 in our measured line there exists an even more important depression, and seeing that the circumstances to which I have alluded as existing on the east side of the lakes Avullu-köl, Kara-köl, Tajek-köl, and Arka-köl prove that this chain of lakes formerly extended farther to the east, there is no real objection to the assumption, that, at some distant epoch in the past, the whole of this region formed a single connected basin filled with water. Nevertheless if we adopt this suggestion, it brings us face to face with certain difficulties in another direction. For if the whole of the basin in question were filled with water, it would have continued to contain water, or at any rate a great part of it would still contain water, even after the Kuruk-darja dried up; the only difference would have been, that the water would have flowed into the western part of the lake, instead of as hitherto into its eastern part. It is possible the great lake may have had a shallow »threshold» across its middle, and so have become in the course of time divided into two basins, of which the eastern basin subsequently dried up, while the western basin gradually contracted on its eastern side.

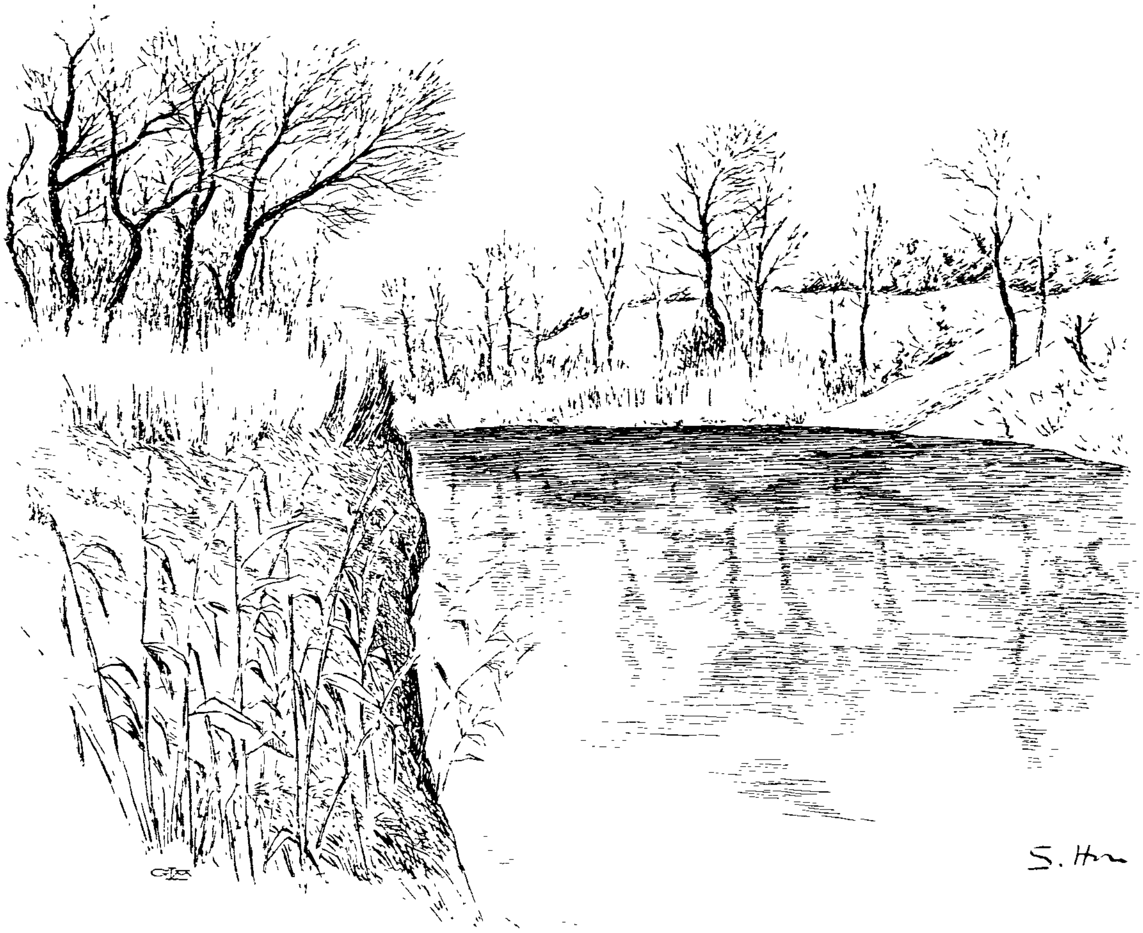


Fig. 158. THE ILEK AT ORDEK-JAGHUTSCH, THAT IS BEFORE ENTERING THE AVULLU-KOL.

However there is no need to have recourse to speculations of this character, for there is another explanation which in an admirable manner agrees with the observations we made in this interesting desert, the surface features of which, as well as its other geographical problems, are so intimately connected with the wind. But in order to trace out this explanation, it is not enough to follow the direction of the water, as I did in 1896; it is also necessary to obtain a more general idea of the surface-relief, and especially of the conformation of the desert. Upon comparing the old Chinese maps with our modern maps, we are astonished to find that a part of the lowermost Tarim has a meridional course, whereas the river taken as a whole formerly flowed almost due east. At that epoch the shortest, as well as the most pronounced, line of fall was from west to east, and one would naturally suppose that any change in the position of its bed would result in the river taking a diagonal course, towards the south-east, that is from the neighbourhood of Tikenlik along the Ilek, across the Avullu-köl, to the eastern part of the Kara-koschun. Instead of that the changes which then took place have resulted in a north-south course, from the Tschivilik-köl and Avullu-köl to Tschigelik-uj. Hence the section from Arghan to Tschigelik-uj or from Avullu-köl to Tschigelik-uj formed a right angle with the Kuruk-darja. The angle formed by the two arms of the Hwang-ho, that is to say the old arm which the stream followed between 1290 and 1852 and the existing arm which it has followed since 1852, only amounts to 60°, and yet those two arms embrace between them the mountainous region of Schantung. In the case too of other deltas whose ramifying arms are spread out wide by the accumulated sediment deposited between them, the angle made by the extreme outside arms seldom amounts to a rectangle, as it does for instance in the Nile. The corresponding angle of the Amu-darja is at first greater than a right angle, but if the whole of the delta be taken into account it is less than half a right angle. The angle between the Meghna and the Hugli in the Ganges delta is 55°, and, to quote only one other example, the deltaic angle of the Tschertschen-darja lies between 50° and 60°.

And just as the meridional course of the Tarim forms a right angle with the Kuruk-darja, so also the chain of lakes Avullu-köl to Arka-köl forms a right angle in relation to the Kara-buran and Kara-koschun. The cause of the river's changing its bed was that to which similar alterations in the Tarim have always been due, and also the same as that which was operative at the mouth of the Hwang-ho, namely the river having come to lie at too high a level relatively to the circumjacent country. Later on we shall again have to consider the forces which have contributed to the origination of an entirely new lake either subsequent to or contemporaneously with this change in the river-bed. What I particularly desire to emphasise just now is the existence of two systems of depressions, intersecting one another, in both the Desert of Tschertschen and the Desert of Lop. One system, running from west-south-west to east-north-east, is that of the Kara-buran, the Abdal lakes, and the Kara-koschun, the lower Tschertschen-darja, and innumerable bends of the existing Tarim, especially the section between Basch-arghan and Ajagh-arghan (Ajrilghan). The other system runs for the most part north and south. The Kuruk-darja was in its time independent of both these systems, following a natural line of fall towards the old Lop-nor.

I have already called attention to the fact that practically all the ramifications and extensions of the Kara-koschun point like fingers towards the east-north-east, flowing in gullies excavated by the wind during the arid period. The west-south-west to east-north-east system of depressions may therefore be regarded as an effect of the wind. At first sight it may seem like a paradox, when I go on to say, that the other system of depressions, which intersects the former at right angles, is likewise a result of the same east-north-east wind. But the contradiction is only apparent; for the same wind that by corrasion hollows out the gullies between the jardangs of the desert likewise heaps up the drift-sand into dunes. The several individual dunes have therefore a steep descent towards the west-south-west; but the great accumulations of countless separate dunes, rising to 100 m. in altitude, which occur in the Desert of Tschertschen, turn their steep faces towards the west-north-west, a result which we traced to the fact that the accumulations decrease in height towards the south, in consequence of which they in that quarter advance more rapidly towards the west. On the whole the chain of bajirs which we followed led us south-south-west. If now this theory is sound, that the rate of progress of the dune-accumulations is proportional to their sand-mass, it might be expected that the bajirs in the Desert of Lop would stretch from the north-north-west to the south-south-east, or from the north-west to the south-east, because the volume of sand in the Desert of Lop decreases from north to south. In that part of the sandy Desert of Lop which lies north of the newly formed lakes, they stretch on the contrary from north-north-east to south-south-west, or in other words parallel to the bajir depressions of the Desert of Tschertschen. At the same time it must be borne in mind, that the bajirs of the Desert of Lop are rudimentary and only some twenty or thirty meters in length, and that they are situated between individual dunes, not between dune-accumulations; moreover, as I have already stated, the sand in this part of the desert is probably affected by the jardangs and the wind-eroded gullies, so that the position which the sand assumes in relation to the wind is not normal.

Both the jardangs and the wind-eroded gullies decrease in number as well as in boldness of relief from north to south, a fact due in no slight degree to the circumstance, that the sand which lies there neutralises the corrasion of the wind. The bajirs we observed between the western extensions of the northern desert lakes and the northern shore of the Kara-koschun are therefore disposed from north-north-west to south-south-east, or rather from north-west to south-east, as indeed might be expected from the direction of the prevailing wind.

These characteristic bajir depressions we regard as having been originated by the wind. While the masses of sand are effected by the prevailing winds, the bare ground between the sand-waves is subjected to the influence of the meridional winds only; consequently the bajirs in the Desert of Tschertschen form spoon-shaped hollows, and these, if situated close to the right bank of the Tarim, get filled with water. The circumstances are no doubt the same in the Desert of Lop, although on a far smaller scale; indeed everything there is on a smaller scale.

Our investigations have brought us therefore to this point, that the bajir depressions are hollows on the lee side of the dune-accumulations, and consequently form a system of depressions all more or less at right angles to the other system, namely the depressions which are excavated directly by the wind. But, as we have seen, the bajir depressions are by no means parallel to one another, a consequence partly of the mass of the sand, partly of the configuration of the ground. If we compare the positions which the bajirs occupy in different parts of the desert, we find them to be oriented in such a way as to suggest that the prevailing wind does not blow uniformly parallel to itself. A consideration of the wind-eroded gullies and jardangs in the Desert of Lop led us to the same conclusion, for in its north-east part they even lie north to south, then north-north-east to south-south-west, and north-east to south-west, suggesting that, while the wind blows from the north or the north-north-east in the northern part of the desert, it comes more from the east-north-east in its middle, southern, and western parts. What direction it blows from in the interior of the Desert of Tschertschen it is impossible to say, that desert being absolutely inaccessible during the period of the storms. Possibly the predominant winds there are due east or east-south-east. Under these circumstances the paths of the winds would describe concentric arcs, the geographical centre of which would be situated somewhere in the neighbourhood of Urumtschi. Of course I do not mean that in this respect there is perfect regularity: for instance, the same east-north-east wind prevails in the valley of the Tschertschen-darja as blows across the marginal lakes of the Tarim, and perhaps we ought to put the centre of the concentric arcs in the vicinity of Ala-kul. But if — and this is for our present purpose the main thing — the paths of the winds do describe arcs, it is no longer difficult to understand, that it is impossible for the bajir depressions to run parallel to one another. Nevertheless in the present connection we get nearer to the actual causal relations if we assume, that the existing relief of the desert is the result of the combined effects of several different factors, such as the volume of the sand, the character of the surface, the relative altitudes, and the wind, but that of all these factors by far the most potent is the wind.

The indications which seem to point to the arc formation of the winds' paths are shown in the subjoined table, beginning with the marginal lakes of the Tarim:

| | |
|---|---|
| Sejt-köl | N. 29° E.—S. 29° W. |
| Basch-köl | N. 25° E.—S. 25° W. |
| Jangi-köl | N. 15° E.—S. 15° W. |
| Gölme-käti | N. 23° E.—S. 23° W. |
| Karaunelik | N. 16° E.—S. 16° W. |
| Ullugh-köl | N. 6° E.—S. 6° W. |
| Begelik-köl | N. 1° E.—S. 1° W. |

This table shows that, as we proceed from west to east, the long axis of these marginal lake tends to coincide more and more nearly with the meridian, the only exception being the Gölme-käti. Actual coincidence is attained in the Tarim below Arghan, and in the Ilek below the Arka-köl. The small bajirs in the southern part of the Desert of Lop stretch from north-north-west to south-south-east. If all these various long axes be prolonged as in Pl. 38, they will be found to meet in the vicinity of Urumtschi, and thus they coincide with the radii of a very large circle. The Jätim-tarim, the Jemischek-kok-ala, and the Ettek-tarim all flow nearly meridionally. The chain of lakes from Avullu-köl to Arka-köl run pretty nearly on a meridian, or at all events from north-north-west to south-south-east. On the other hand the portion of the Tarim between Karaul and Arghan, and the portion of the Kontsche-darja between Korla and the Avullu-köl, have made themselves quite independent of the lines of the older depressions: they intersect the continuations of the other two systems of depressions and follow the fall prescribed by the trough-shaped conformation of the country, a conformation which in the locality alluded to is still fairly distinguishable.

What now was the aspect of this region during the period of its hydrographical development, the occurrence of which is proved not only by the actually existing data, but by the evidence of the Chinese maps? There can be no doubt that south of the lowermost Tarim (= Kuruk-darja) there extended a »sea of sand« similar to that which at the present day is found everywhere along the south side of the Tarim. South of the lake of Lop-nor the country must on the other hand have been virtually free from sand, just as the country is now south of the Kara-koschun, and that because by far the greater part of the drift-sand — probably the whole of it — which was blown across the lake, dropped into it, and so helped to fill up its basin. What happened when the Tarim shifted its position? This question is difficult to answer, because we do not know in what way the change in question took place. But whether it took place by successive steps, one after the other, or was effected all at once, as in the case of the Hwang-ho, the result was equally the same. In the former case the dunes would be washed away piecemeal, until the remnants that were left fell an easy prey to the storms. In the latter case the relatively narrow strip of desert which existed north-east of the new river-bed would be driven by the east-north-east wind directly against the left bank of the Kontsche-darja and the masses of sand which slipped down the lee sides of the outermost dunes would be swept away by the current into the river-bed, helping to fill up, not only the bed itself, but also any depressions and lakes there may possibly have been there. What the Kontsche-darja thus effected was to raise a barrier against the further westward advance of the mass of sand existing in that part of the desert. On the other hand as a consequence of the migration of the current from the Kuruk-darja to the Kontsche-darja (we are for the present disregarding the Tarim), the volume of the sand north-east of the lower Kontsche-darja or the Ilek increased rather than diminished in amount, because the old Lop-nor and the Kuruk-darja no longer placed any hindrance in the way of the unrestricted movement of the drift-sand towards the west-south-west. The sandy desert begins indeed immediately above Turfan-karaul; above that point there is no drift-sand.

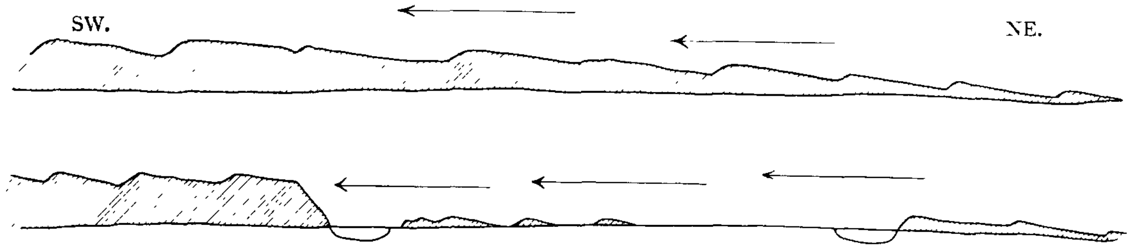


Fig. 159.

One effect that the Kontsche-darja must inevitably have produced was to free from sand its right bank or, generally speaking, the country immediately south-west of the river, because the sand-dunes which previously existed there must have travelled farther towards the west-south-west, without any successors coming from the east to take their place. Hence the region that intervenes between the Kontsche-darja or the Kuntschekisch-tarim and the Tarim itself must in course of time have become swept entirely clean of sand. And such exceptions to this as exist are to be explained by the fact that the vegetation which followed the water bound the sand together over a not inconsiderable area. What must have happened is illustrated in fig. 159. The upper figure shows a section of the desert from north-east to south-west at the epoch of the ancient Lop-nor. The lower figure depicts what must have happened with regard to the arrangement of the sand after the same belt of country was cut through by two river-beds in a direction almost at right angles to that of the prevailing wind. The reason the high dunes on the right bank of the Tarim plunge vertically down into the river is the continual straining of the stream towards the south-west, the consequence being that it gradually washes away the sand at the base of the dunes.

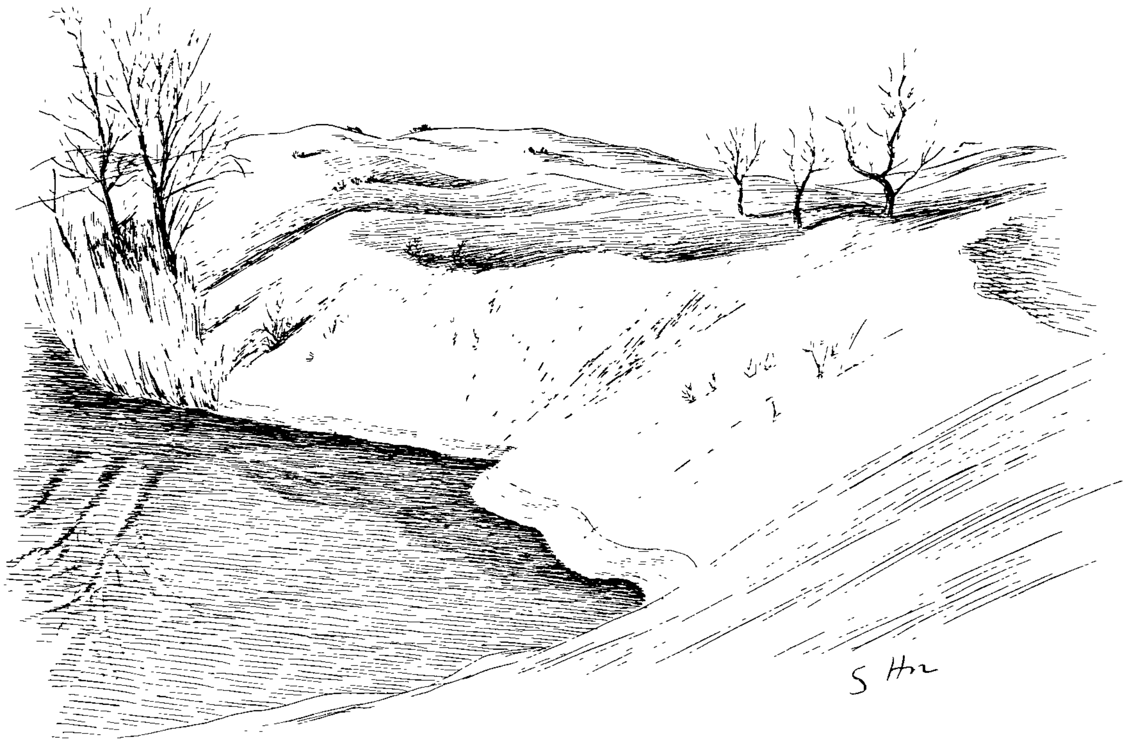


Fig. 160. THE ILEK AT ORDEK-JAGHUTSCH; SAND-DUNES DESCENDING ABRUPTLY INTO THE RIVER ON ITS EASTERN BANK.

Several circumstances conspire to prove that the country south of the system of the Tarim and the Lop-nor as depicted on the Chinese maps, that is in the first centuries of our era, consisted of nothing but sandy desert, without the smallest trace of an oasis or other variation. Along the left bank of the whole of the lower Tschertschen-darja we found the high sand very close to the stream, often directly touching its bank, e. g. at Tschükün, where the delta proper begins. The western and southern parts of the Desert of Lop are still filled with drift-sand. Finally, there is a good deal to be learnt from the dry bed of the Ettek-tarim. This stream used to flow on the whole from north to south, the only deviation being at Kultschuk-köli and Dötö, where its course was south-east. Generally speaking therefore, the line of depressions linked together by the Ettek-tarim runs parallel to the chains of bajirs which exist nearest to them both on the east and on the west. There can be no doubt, that at the time when the river first turned towards the south at Basch-arghan, and formed the Ettek-tarim, it made its way along a string of bajir depressions that already existed between two dune-accumulations. These already existing hollows soon became filled with water, and no doubt for some time formed a series of small lakes, similar to the existing chain of the Sadak-köl, Nias-köl, Tschong-köl, etc, that constitute the eastern waterway. In process of time these small lakes became filled with fluvial sediment, and very soon the regular channel, possessing approximately the same breadth throughout, came into being, i. e. the south-going stream known subsequently as the Ettek-tarim; and lastly the forest spread along its bank.

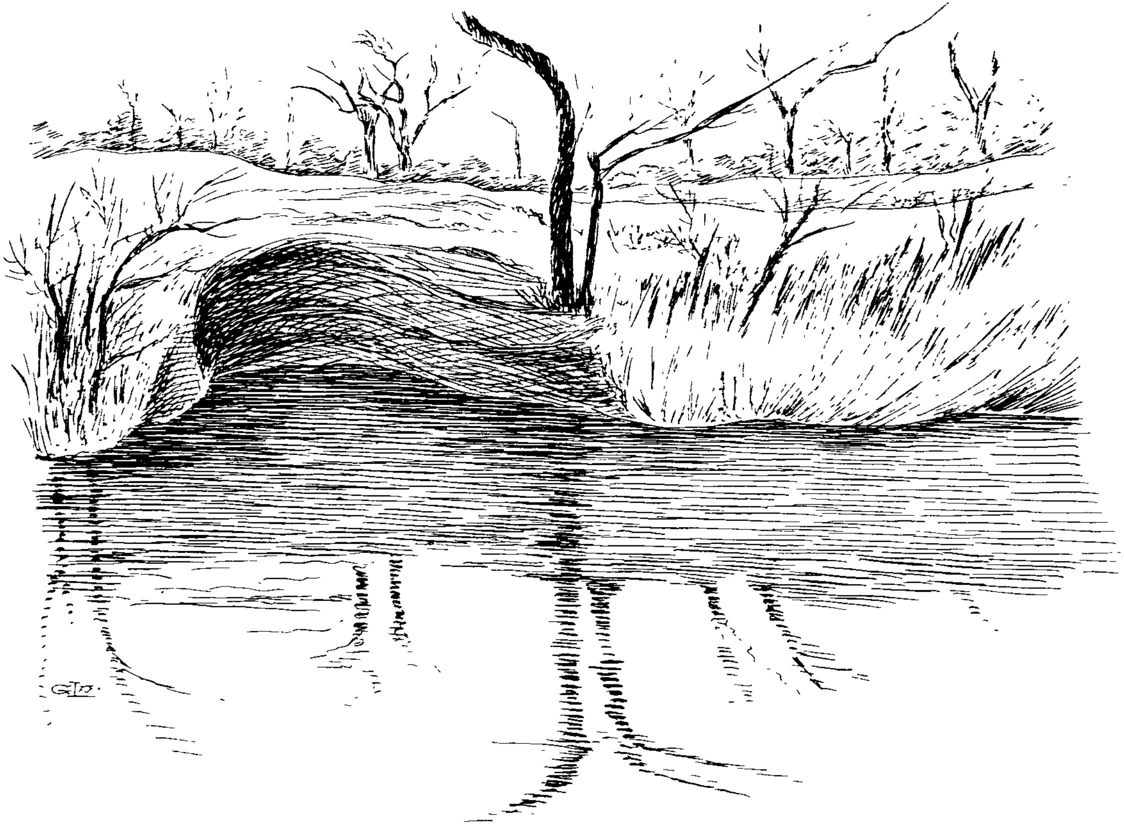


Fig. 161. ANOTHER VIEW FROM THE SAME PLACE, SHOWING AN EDDY OF THE RIVER ENTERING THE SAND ON THE EASTERN BANK.

Nor is this description of what took place either a vague assumption or a mere speculation: the occurrence *must* of necessity have happened in this way. For east of the Tagh-kum there still exists a bajir, drawn out north and south, and forming merely one link in a chain of bajirs that stretched exactly parallel to the Ettek-tarim, although merely insignificant fragments of it now survive, owing to its having been in great part destroyed by the wind since the Tarim assumed its present course, and thus raised an insurmountable barrier to the continued advance of the drift-sand. It is equally evident, and equally clear, that the new bed of the

Tarim from Ajagh-arghan downwards likewise followed a pre-existent chain of bajir depressions, running almost exactly parallel to the chain of the Ettek-tarim.

The differences that obtain between the Ettek-tarim and the Tarim have nothing whatever to do with the existence of the series of original bajir depressions. The former stream below Basch-arghan is generally much more plentifully equipped with forest than the latter is below Ajagh-arghan. Whereas the latter below Schirge-tschapghan is entirely destitute of forest, we already found forest beside the former at the point where we approached it, along the line of the route running to the village of Lop.

Again, the Ettek-tarim is more deeply embedded in sand than the Tarim is; indeed at this point there exists on the right bank of the latter a pretty broad zone of bare steppe, and its eastern or left bank is likewise pretty free from sand, or at all events it has far less than its neighbour has. It is precisely this circumstance that constitutes the greatest difference between the two rivers. The left or eastern bank of the Ettek-tarim is accompanied by a considerable ridge of dunes, which culminates in the conspicuous sandy eminence of Tagh-kum. In some places this ridge of dunes has begun to encroach upon the river-bed since the stream dried up, and thus the encroaching sand, shaping itself into thresholds, tends to restore the bajir depressions to their original appearance of a chain of detached hollows. The reason there exists no corresponding ridge of dunes on the east bank of the Tarim is that the Ilek, below the Arka-köl, served for a prolonged period as the sole channel for the entire volume of the Tarim system, which then proceeded, *via* Schirge-tschapghan and through the bed of the Tokus-tarim, to the problematical Utschu-köl, and that the whole of the eastern waterway fenced off the drift-sand sufficiently long for the region between the Ilek-Tokus-tarim and the lower Tarim to be swept practically free from sand. On the other hand there are dunes of not inconsiderable magnitude gathered on the eastern bank of the Ilek and on the northern bank of the Tokus-tarim, because in the desert regions to the north-east there exists no hydrographical hindrance to the free advance of the drift-sand.

The existing disturbance in the arrangement of the sand is therefore due to the three parallel rivers, the Ilek, Ettek-tarim, and Tschong-tarim, and that in the order named. Previously this region formed a compact sandy desert with an extraordinarily regular architecture and parallel chains of bajirs extending from north to south. The accumulations of sand grew at the same time continuously higher and more massive from east to west, the section being that shown in A on fig. 162. For some time after the Tarim broke away to the south and formed the Ilek arm along one of the chains of bajirs, no other change was observed in the disposition of the sand except that a continually broadening belt on the right (west) bank of the Ilek became free from sand (B). Later the water made a fresh path for itself through a more westerly chain of bajirs, the Ettek-tarim, and this stream was hemmed in by even higher accumulations of sand than the Ilek. The section is shown in C; whereas D shows the arrangement at the present time, the region between the Ilek and the Tarim being practically free from sand, while between the Tarim and the Ettek-tarim considerable dunes still persist. If the river maintains its present position for a sufficiently long period of time, these dunes too will continue their journey westwards, and overwhelm not only the bed, but also the forest, of the Ettik-tarim.

A rough sketch of the water's advance towards the south is given in fig. 163. A B C D E represent a series of bajir depressions. The surface of the ground falls a couple of meters between A and E, but the greatest depth in A lies a couple of meters lower than the greatest depth in E. Since then A has a lower absolute elevation than E, the water, after filling the whole of the deep depression A, must run over its southern edge and proceed to B, which it will fill in like manner, and so on until it gets to E, where the surface-level is lower than in A, though the depth is very slight. If then we travel along the line A in fig. 164, i. e. along the bank of the newly formed waterway, we find a gentle fall from north to south, but if we proceed along the line B from one depression depth to another, we observe a rise from north to south. This is precisely what the actual facts are. If now we prolong these lines towards the north as far as the latitude of the Tajek-köl, we shall find that there is no change in the relations. In that direction the line A, which indicates the water-surface, continues to rise, the line B to fall, until in the Tajek-köl we have the deepest depression in the entire chain; and from that point again the depth decreases right up to the Kuruk-darja. The Ilek arm, which lies next to the Tajek-köl on the west, and in which we sounded a depth of 12.55 m., may be regarded as the northward continuation of the chain of bajirs through which the Tarim now flows towards the south, so that here again the depth decreases towards the south. Finally the deep depressions around Markat may be regarded as the northerly continuation of the Ettek-tarim chain of depressions, in which the relations are in every respect the same as in the other two series to the east.

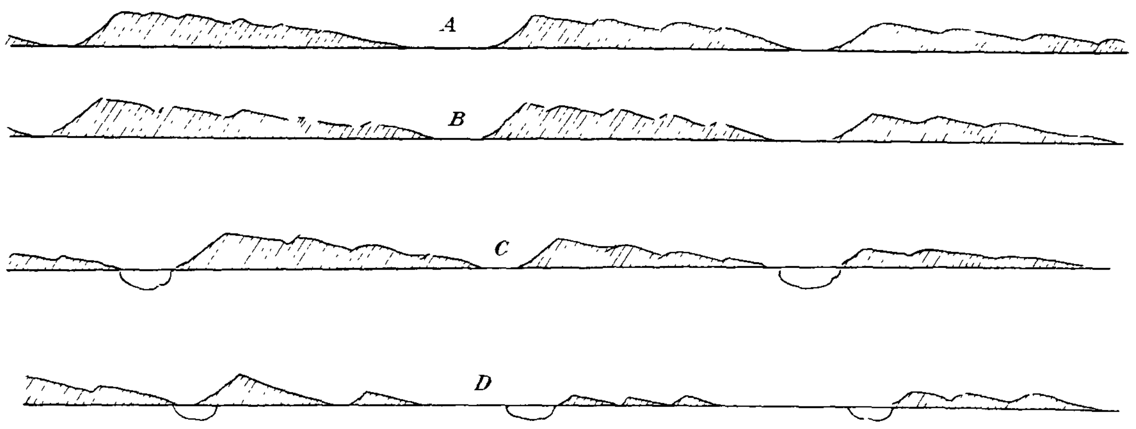
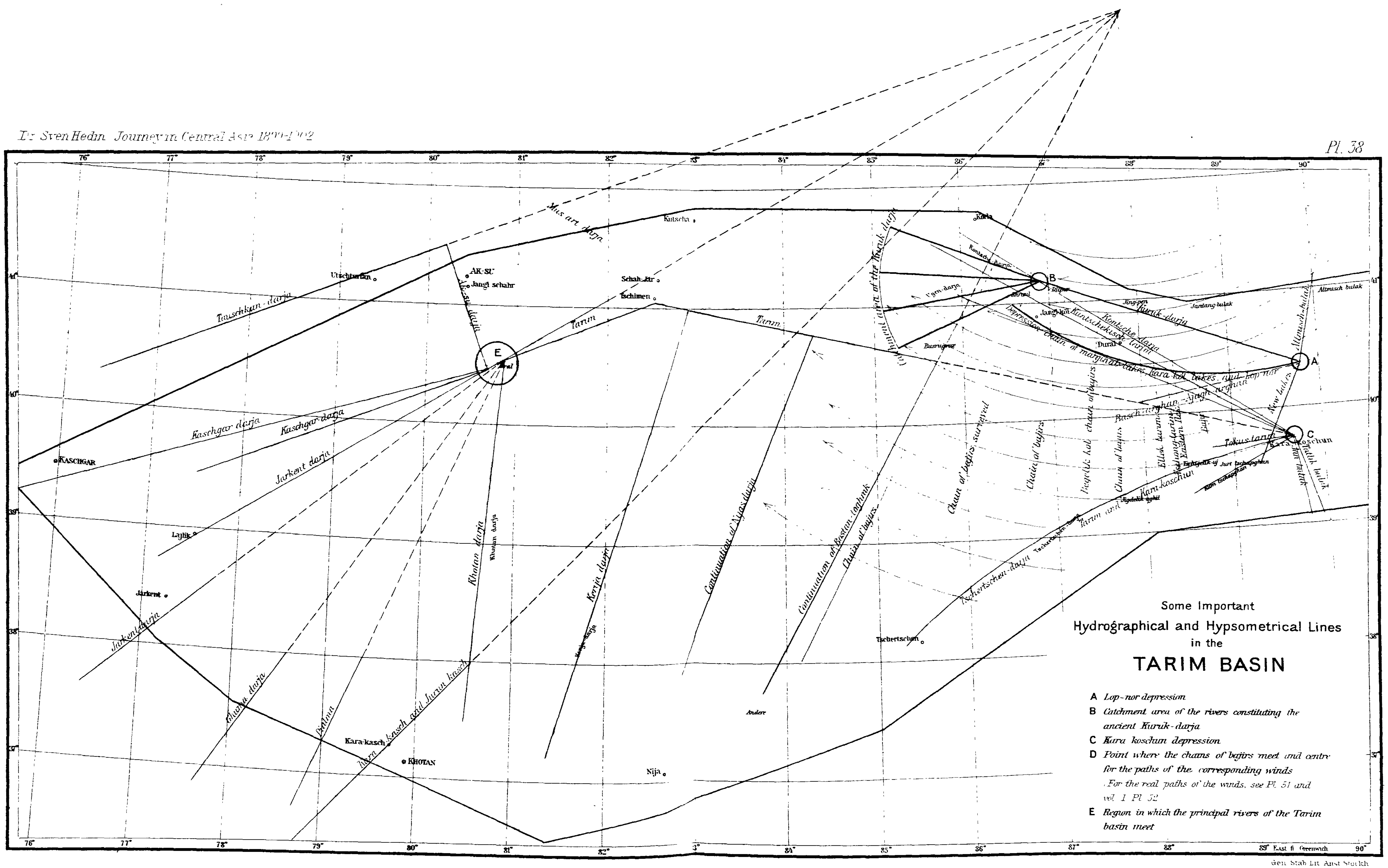


Fig. 162. IN A AND B WE HAVE VERTICAL SECTIONS FROM W TO E THROUGH ORDINARY BAJIRS AND DUNE ACCUMULATIONS IN THE REGION WHERE THE MERIDIONAL TARIM NOW IS SITUATED. IN C WE HAVE TO THE LEFT (W) THE NEW-COMER, THE ETTEK-TARIM, AND TO THE RIGHT (E) THE ILEK. IN D THE ETTEK-TARIM IS DRY, THE SAND ACCUMULATION IS COVERING ITS OLD BED, THE PRESENT TARIM IS FORMED IN THE MIDDLE OF THE SECTION, AND TO THE RIGHT IS STILL THE ILEK WITH ITS WESTERN BANK SWEPT FREE FROM SAND. THE FIGURE SHOWS HOW THE RIVERS HAVE ALWAYS MADE THEIR COURSES IN THE EXISTING CHAINS OF BAJIR-DEPRESSIONS.

Hence, strange as it may appear at the first sight, that the chain of lakes Avullu-köl to Arka-köl is so long and so narrow, and stretches from north-north-west to south-south-east, at right angles to the west-south-west to east-north-east direction which prevails in the Kara-koschun, and probably also in the dry basin of the Lop-



Some Important

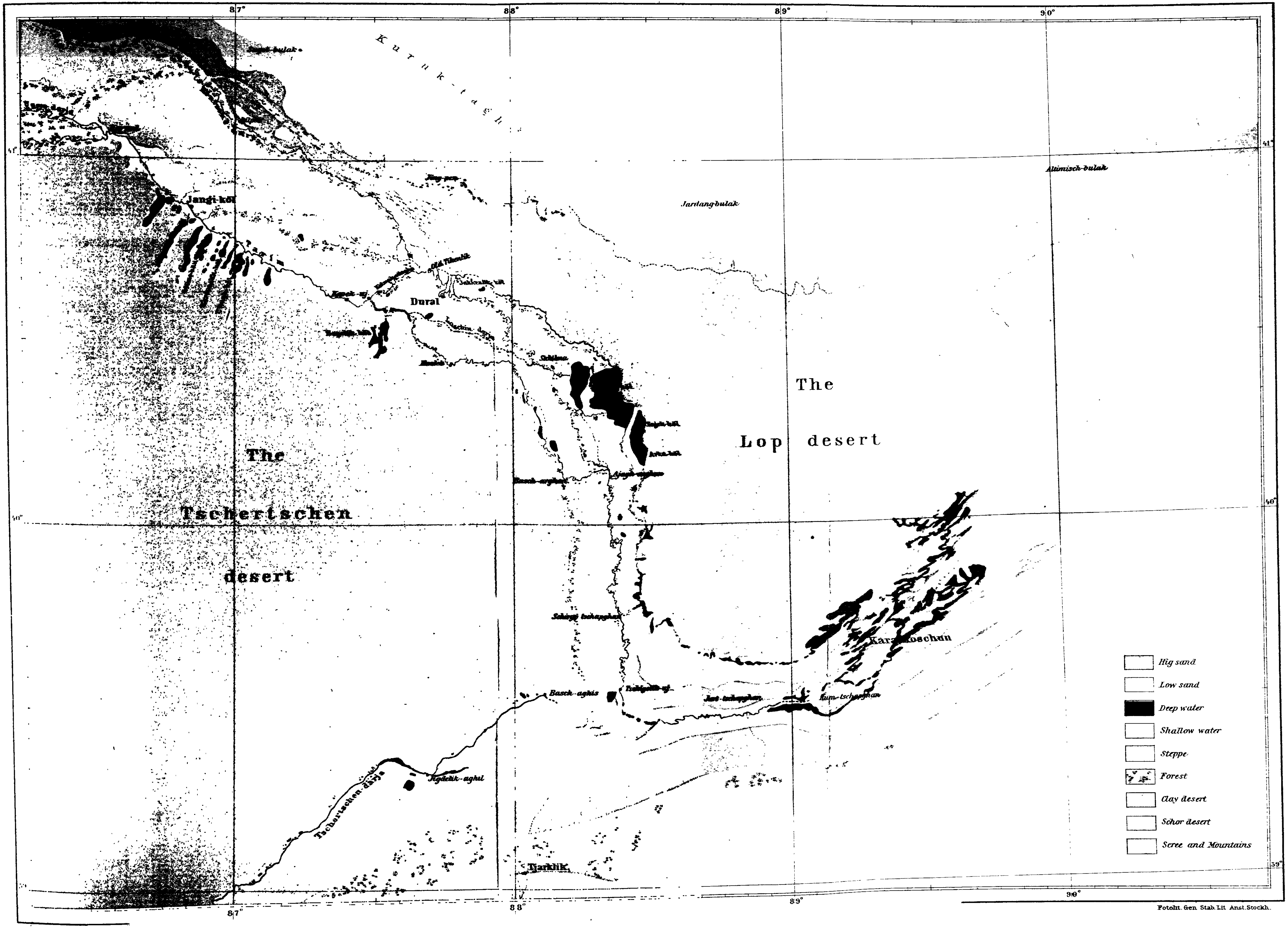
Hydrographical and Hypsometrical Lines

in the

## TARIM BASIN

- A *Lop-nor depression*
- B *Catchment area of the rivers constituting the ancient Kuruk-darja*
- C *Kara koschun depression*
- D *Point where the chains of bajirs meet and centre for the paths of the corresponding winds*
  *(For the real paths of the winds, see Pl. 51 and vol. I Pl. 52*
- E *Region in which the principal rivers of the Tarim basin meet*

Gen. Stab. Lit. Anst. Stockh.


87°
88°
89°
90°
41°
40°
39°
Kuruk-tagh
Jangi-köl
Tarim
Kapek-uj.
Old Tikenlik
Dural
Jardang-bulak
Altimisch-bulak
The Lop desert
The Tschertschen desert
Schirge-tschapghan
Basch-aghis
Ait-tschapghan
Kum-tschapghan
Kara-koschun
Tschertschen-darja
Jugdelik-aghil
Tjarklik
Hig sand
Low sand
Deep water
Shallow water
Steppe
Forest
Clay desert
Schor desert
Scree and Mountains
Fotolit. Gen. Stab. Lit. Anst. Stockh.

nor, nevertheless, after the discussion I have set forth above, the relative positions of these axes will, I have no doubt, appear perfectly clear and natural. The lakes simply coincide with a line of old bajir depressions, and the narrow passages which separate them are simply the former thresholds, which, previous to the advent of the water, divided the bajirs one from another. A comparison of the valley of the Ettek-tarim from Tana-baghlaghan to Kutschmet (see Pl. 17 and 18 of the Atlas) with the series of bajirs No. 13 to No. 25 in the Desert of Tschertschen (see Pl. 13 of the Atlas) will convince us at once that the former, the valley of the Ettek-tarim, must originally have presented the same appearance, and have possessed the same morphological characteristics, as the latter series of depressions does now. If the altitudes would allow a river to flow through this succession of bajirs, it would give rise to a valley which down to the minutest details resembled that of the Ettek-tarim. From No. 13 onwards the depressions would gradually become filled with water and the thresholds would be broken down, then forest would slowly grow up, especially on the east side, where the steep dune-slopes afford shelter against the storms (Vol I. fig. 365). The fact of this chain of bajirs running from north-north-east to south-south-west, while the Ettek-tarim runs from north-north-west to south-south-east, fully agrees with the law that governs the morphological orientation, the main features of which are shown on the accompanying sketch-map (Pl. 38).

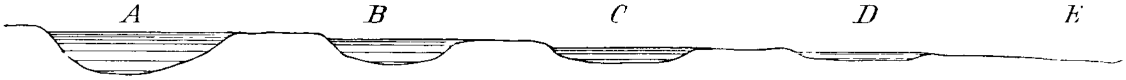


Fig. 163.

It would carry me too far to dwell upon the relations which each and every one of the meridional lakes of the Tarim delta bears to the original bajir depressions; nevertheless I cannot abstain from analysing the eastern lakes which I discovered in the year 1896, because the morphological law we are considering is in them exemplified with such extraordinary clearness, and will then admit of being applied to the other lake-groups in the neighbourhood.

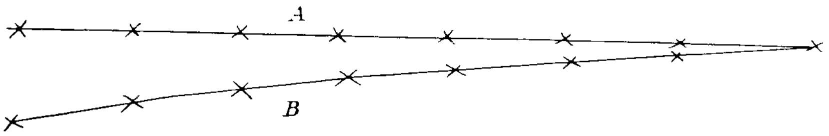


Fig. 164.

In the first volume of this work I have given a description of the lakes and their hydrography in general, without entering into any geographico-genetic details. From these it appears that the map I made in 1896 is not quite correct, because at that time I travelled along their right shores only, and had no opportunity of investigating the complicated hydrographical relations which obtain on the west side. Now however I discovered that the chain of lakes consists of three basins only, the Avullu-köl, the Tajek-köl, and the Arka-köl. The Kara-köl lies west of the two first-mentioned, being separated from them by a low, narrow neck of land, on which are drift-sand and tamarisk-mounds. Consequently the Kara-köl is a member of the series of bajirs that lies nearest on the west to the series in which the three first-mentioned lakes occur. Another notable error into which I fell in 1896 was accepting the statement my guides made, to the effect that the Kum-tscheke Ilek issued direct from the Arka-köl, whereas in actual fact it comes from the Suji-sarik-köl, and flows towards the south-south-east, west of the Kara-köl and Arka-köl, and receives from these lakes but an insignificant influx of water. This river belongs therefore in that particular neighbourhood, west of the Kara-köl, to a third series of bajirs; but in the locality west of the Tajek-köl and Arka-köl it belongs no doubt to the same series as the Kara-köl does, after it has apparently cut diagonally across a dividing strip of land which formerly formed part of one of the lofty accumulations of sand.

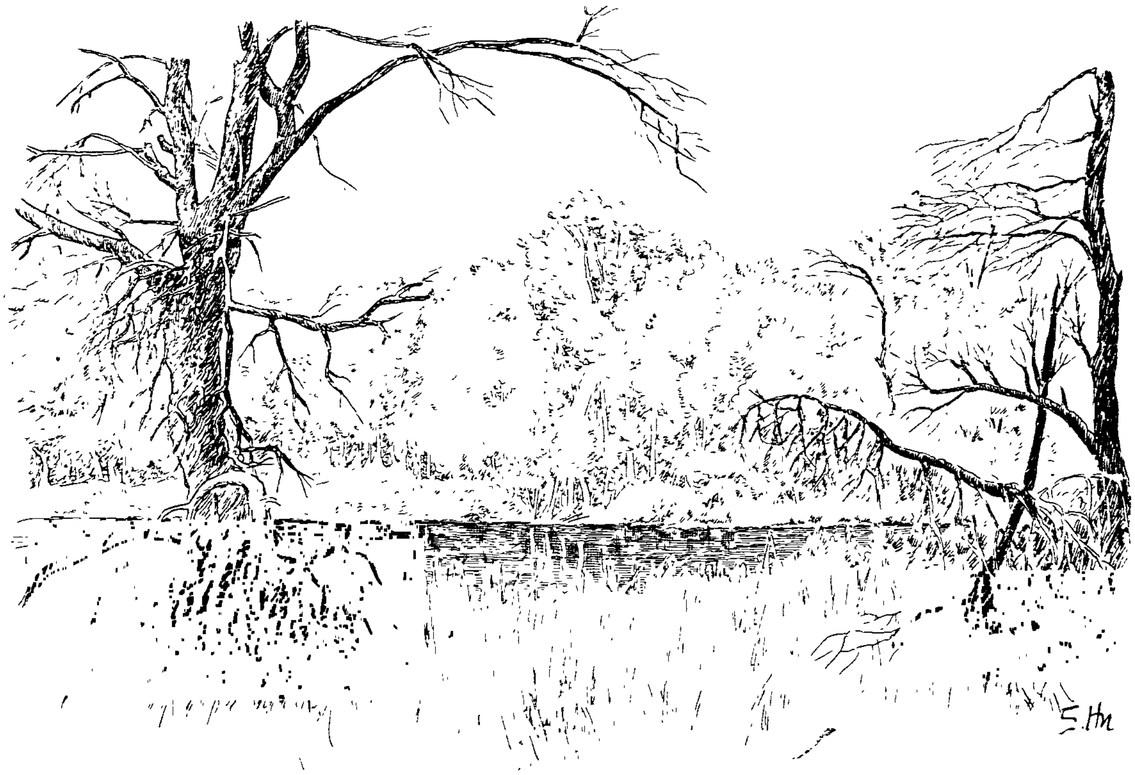
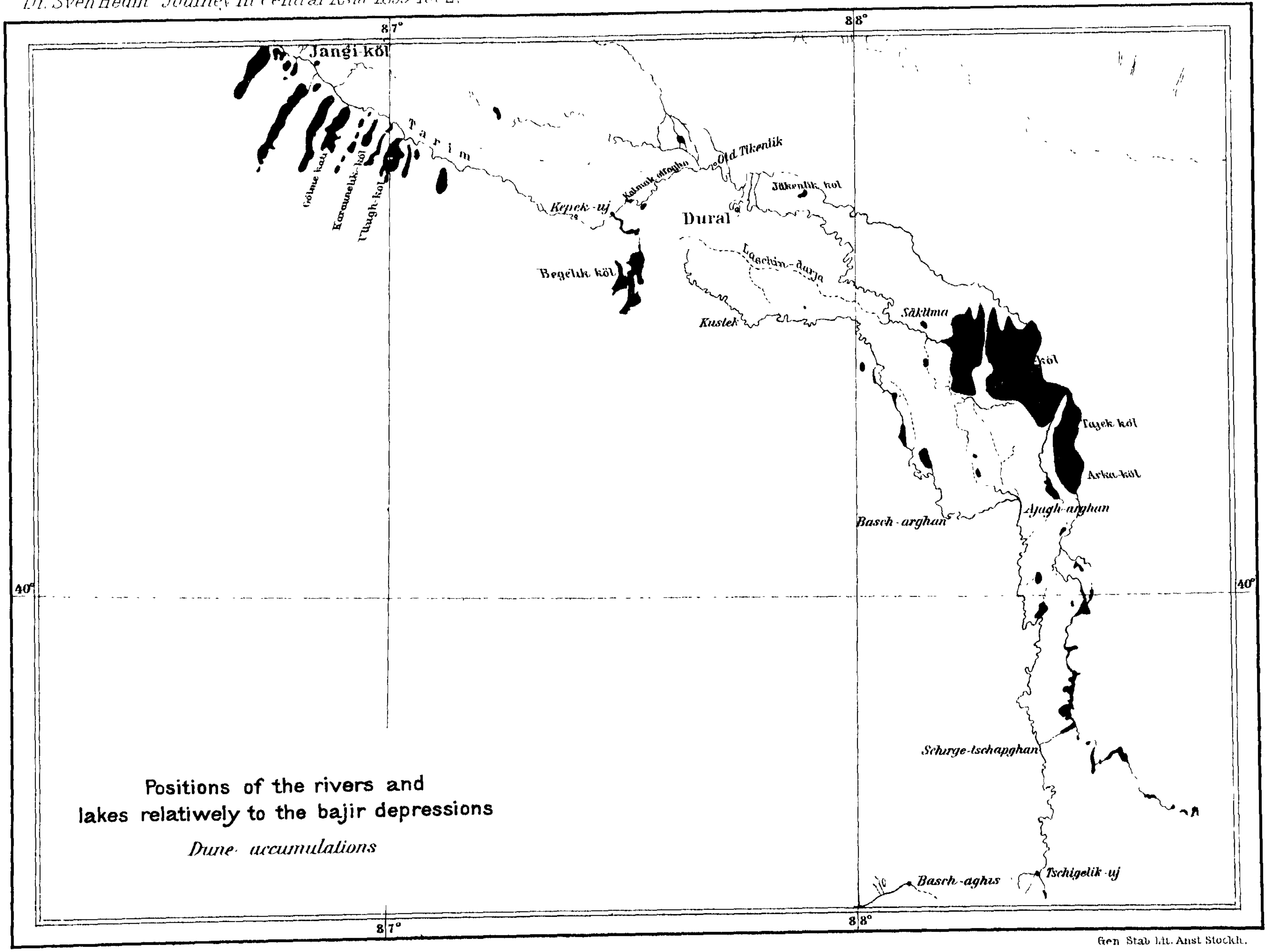


Fig. 165. FOREST ON THE BANKS OF THE ILEK, BELOW KUM-TSCHEKE.

If then the Avullu-köl, the Tajek-köl, and the Arka-köl are members of the same chain of bajirs, they ought to be bordered on the east by a ridge of high dunes, in the same way as the former series of depressions; and this really is the case, as I learned only too well when in 1896 I had to make a heavy and difficult march through the sand in question, though it is now in great part bound together by vegetation. In a similar way, this same series of bajirs, that is to say lakes, ought to be also bordered by a corresponding strip of sand on the west; and this I found to be the case in 1900, when I crossed on foot, at three separate places, the long



Positions of the rivers and lakes relatiwely to the bajir depressions

*Dune accumulations*

Gen. Stab. Lit. Anst. Stockh.

narrow belt of land which separates the Ilek or Jangi-tarim from the lakes. Over against the Arka-köl this dividing strip of firm ground is 810 m. across, over against the Tajek-köl 710 m., and over against the Kara-köl 4145 m. It is dotted over with numerous dunes, in great part overgrown with vegetation, and with tamarisk-mounds; but the original form of the sand-accumulations is exceptionally well preserved, especially in the locality last indicated (see vol. I., Pl. 55). The sand is disposed precisely as it is in the Desert of Tschertschen, highest in the west, though it decreases towards the east, until on the western shore of the Kara-köl there is none at all. As we travel up the Ilek, which is here a stream of some magnitude, we are at first inclined to think that these lakes are marginal lakes belonging to the river, but we soon discover that they have nothing whatever to do with it, but are nothing more nor less than a series of ancient bajir depressions which in quite recent times have become accidentally filled with water from the Bos-ilek.

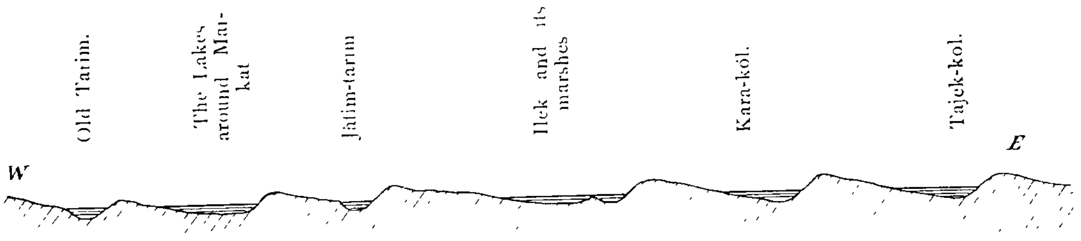


Fig. 166.

Proceeding still farther west, we come to the next following series of north-south depressions. From a high sandy mound between the Ilek and the Tajek-köl new marshes were distinctly visible to the west, bordered on the more distant side by a similar long narrow strip of land, or rather ridge of sand. Beyond that lies the Jätim-tarim, then the newly formed lakes of the Tarim at Markat, and then the old bed of the Tarim (Jarkent-darja); while beyond that again come the numberless

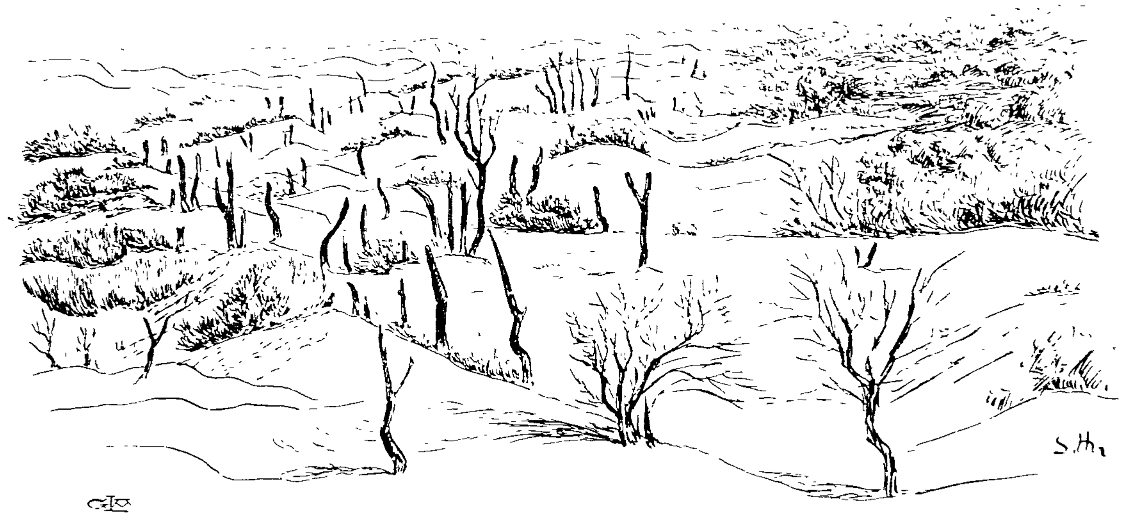


Fig. 167. EAST SHORE OF ARKA-KOL. VIEW LOOKING SOUTH, SHOWING SAND-DUNES PROCEEDING TOWARDS THE WEST ACROSS THE LAKE. IN THE MIDDLE DEAD FOREST; TO THE RIGHT FRESH VEGETATION ON THE VERY SHORE OF THE LAKE.

chains of depressions that we have already dealt with. Fig. 166 gives a vertical section from east to west right across all these waterways and the sand-accumulations which separate them, as they appeared before any water came to fill them. In the tracts which separate the rivers the sand has for the most part been already blown away or bound fast by vegetation. Between this vertical section and that which I gave through the marginal lakes on the right bank of the Tarim (see vol. I., Pl. 43) there *must* of necessity exist a great similarity; it is dictated by the very nature of the case.

If now these eastern lakes occupy depressions of precisely the same morphological rank as those which are occupied by the desert lakes of the Tarim, then the bathymetrical relations in the two series ought to be identical, that is to say, the greatest depths ought to be in the eastern parts of the lakes. And there can be no doubt that this really is the case, although it is difficult to prove it, owing to the eastern shores of the former set of lakes having been distorted in quite a different manner from what they have been in the marginal lakes of the Tarim. In the case of the latter series, e. g. Gölme-käti, Karaunelik-köl, and Ullugh-köl, the eastern shore forms a pretty even line, but little indented, pointing to a uniform advance of the dune-ridge which borders it, and the vegetation is scanty. In the case of the other, more easterly series, the Avullu-köl, Tajek-köl, and Arka-köl, the westward advance of the sand is extremely irregular, some portions of the sand being retarded by the more abundant vegetation; hence the shore line is very much broken up. The Begelik-köl, situated between these two groups of lakes, forms at the same time an intermediate stage between them both, for its eastern shore is more broken up than in the case of the series to the west of it. These dissimilar circumstances must of course to a great extent influence the course of the isobaths. The gigantic dunes beside the western lakes advance without any check, but those beside the eastern series are seriously affected in their rates of progress by the vegetation, while there are also promontories and tongues of sand, not yet bound by vegetation, which project a long way into the lakes. In them the greatest depths appear to be in the middle rather than under their eastern shores.

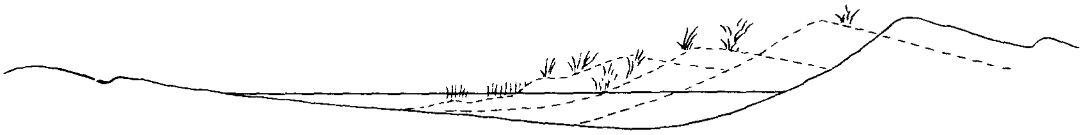


Fig. 168.

Generally speaking however, it cannot be denied that there does exist a great resemblance in the bathymetrical relations of the two series, as the following comparison will show —

| | | max. depth | mean depth |
|---|---|---|---|
| Western lakes | Karaunelik-köl | 9.40 m. | 5.61 m. |
| | Ullugh-köl | 10.00 | 4.92 |
| | Begelik-köl | 11.00 | 3.67 |

| | | | |
|---|---|---|---|
| Eastern lakes | Avullu-köl | 6.10 m. | 3.92 m. |
| | Tajek-köl | 9.52 » | 6.50 » |
| | Arka-köl | 7.13 » | 5.80 |
| | Kara-köl | 6.52 | 5.32 » |
| | Tschivilik-köl | 5.15 » | 4.07 » |

The maximum depth in the former series is generally the greater because of the dissimilarity between the eastern shores of the lakes in the two series; but the mean depths are about the same. The average of the mean depths of the three western lakes is 4.73 m., and the average of the mean depths of the five eastern lakes is 5.12 m. We have only to separate out of the eastern series the three lakes which, as in the case of the other series, lie side by side, namely the Tschivilik-köl, the Kara-köl, and the Avullu-Tajek-köl — the last two have a common mean depth of 5.21 m., 3.92 m. and 6.50 m. being regarded as their characteristic depths — and then take their mean depth, and we get as a result 4.87 m., or almost precisely the same value as for the western lakes. In a word, it is not only the orientation of these eastern lakes, drawn out north and south, and the fact that they are embedded between two accumulations of dunes, but also their similarity in the matter of depth, that testify to the correctness of the theory I have advanced, namely that they were formed in the same way as the western lakes, and thus occupy a series of former bajir depressions.

The frequent presence of mature forests on the banks of the Ilek (Bos-ilek) above Avullu-köl may be accepted as evidence that this is an old stream. For the same reason we may look upon its lakes as old. The only thing we know about them for certain is that they existed prior to 1759; but in all probability they are several hundred years older than that. However that may be, we naturally ask ourselves, how these lakes have been able to maintain themselves so long and to preserve depths amounting to 9.52 m. For in this respect these lakes are very different from those to the west. But then the western (Tarim) lakes are not basins along the line of a river-arm, through which the current merely passes; they are only fed by very narrow channels. These eastern lakes have undoubtedly contained water for a considerably longer period than the Ettek-tarim, and in every case they have contained water for a longer time than the Tarim between Ajagh-arghan and Tschigelik-uj. If now the latter stream has entirely filled the bajir depressions through which it first flowed, it may appear strange that the Avullu-köl, the Tajek-köl, and the Arka-köl, although older than those depressions, have not become filled in a similar way. But for this there exist two different causes. For one thing, these lakes lie in a deeper part of the Lop depression, and in the next place the Ilek carries an exceptionally small quantity of sediment. The river derives all its water from the Kontsche-darja, which is perfectly limpid when it issues from the Baghrasch-köl. Such solid material as the river subsequently takes up and carries with it on its way south-east is deposited in the thick reeds of the Maltak-köl and several other lakes, if it is not indeed deposited before it reaches them, so that upon issuing from these lakes the Ilek is again as bright as crystal. From the Maltak-köl to the Avullu-köl its bed is deeply trenched, so that the bright clear water often looks quite black, and for long distances the river-bed presents the appearance of an artificially made canal. The considerable volume of water which the river contains moves at an extremely slow rate, and so far from exercising any erosive energy and absorbing solid material from the sides of its bed, it even allows any material that does chance to find its way into it, blown thither for the most part by the wind, to settle at the bottom. Upon entering the Avullu-köl therefore the water of the Ilek is pure, or at all events the sediment it carries is so insignificant that it would require a very long time to make itself perceptible as a deposit at the bottom of the lake. As one might with good reason expect, the Avullu-köl is somewhat shallower than the lakes to the south of it. It may be regarded as a sheer physical necessity that, unless other changes take place in the meantime, the chain of lakes — Avullu-köl, Tajek-köl, and Arka-köl — will inevitably be filled, for vast quantities of drift-sand and drift-dust settle in their basins, and to them large quantities of materials are added by the decaying vegetation. Since then the cubic capacity of these lakes is being in this way lessened, it follows that simultaneously, and in a corresponding degree, the stream which issues from the lowermost of the series, the Arka-köl, increases, the ultimate result being, that it will form a direct continuation of the upper Ilek. If now we project our minds backwards in time, we must picture this stream as growing smaller and smaller, in the same proportion as the lakes were correspondingly bigger than they are now. Indeed the time cannot be very distant when the Ilek emptied itself into the Avullu-köl without at the same time any water issuing from the Arka-köl, because the lakes were then so great that an even balance was maintained between evaporation and influx. Nor is the cogency of this reasoning at all impaired by the fact that

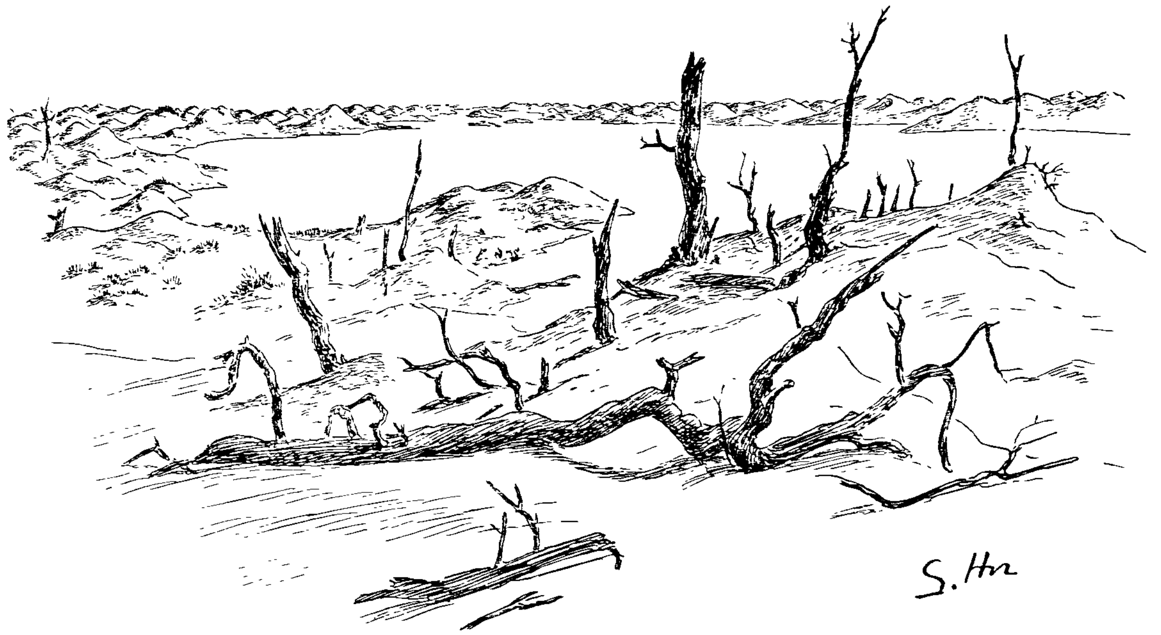


Fig. 169. PART OF SADAK-KOL IN 1896, SHOWING A REGULAR BAJIR-DEPRESSION FILLED WITH WATER. THE DEAD FOREST SHOWS, THAT THERE WAS AN EARLY WET PERIOD FOLLOWED BY A DRY PERIOD, WHICH KILLED THE TOGHRAKS. AT THE PRESENT TIME THE DEPRESSION IS ONCE MORE FILLED.

at the present time two or three other streams flow out of the triplet lakes. We have only to suppose that the Ilek poured its Kontsche water into its terminal lake, precisely as the Tarim now pours its water into its terminal lake, the Kara-koschun; so that from this point of view these triplet lakes may be regarded as bastard or deformed descendants of the old Lop-nor.

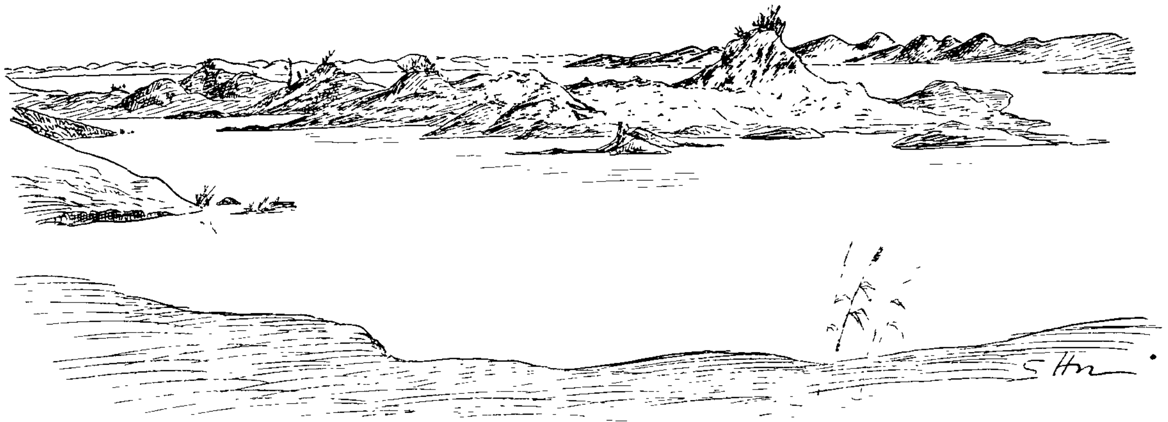


Fig. 170. NIAS-KOL; A SPECIMEN OF AN OLD BAJIR-DEPRESSION FILLED WITH WATER.

All the same the exceptional limpidity of their waters is not alone sufficient to account for the tenacity with which these triplet lakes maintain their existence. In the same latitude, but farther to the west, there exist a number of other lakes — the Kara-köl, Tschivilik-köl, Suji-sarik-köl, together with others, and again the lakes around Markat. Certain of the upper lakes of these groups are entered by rather turbid streams. All the waters which unite definitively at Arghan come through these lakes, dropping all their sediment on the way, and if, notwithstanding this, the water at Arghan is not clear, the reason is that they pick up fresh sedimentary matter in the regions they traverse after issuing from the lakes just mentioned. These lakes therefore, the Tschivilik-köl and those of the upper Tarim, threaten to fill much sooner than the chain of lakes to the east, and the sedimentation proceeds, as we found in several places, from north to south. The same thing is true also

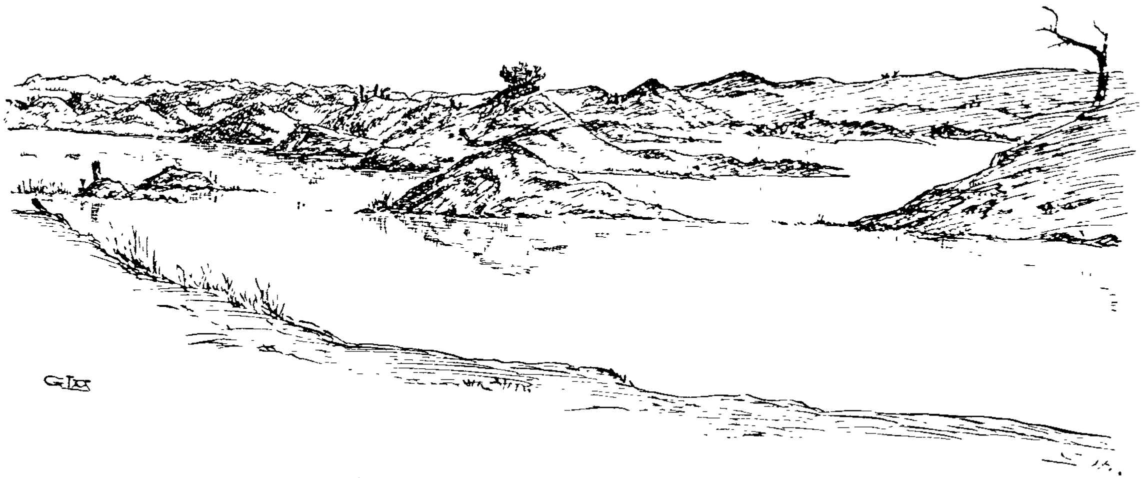


Fig. 171. ANOTHER VIEW OF THE SAME.

of the lower Ilek; for instance, we have found that the Sadak-köl had become in great part filled in the course of only four years. The Tarim lakes in particular are certainly condemned to early destruction; in fact they are ambulatory basins, and when they get full of sediment, and the river has built up for itself fresh containing ramparts, it will soon quit its bed and form new lakes by the side of the old ones. Higher up, where the direction of the river and the long axis of the lakes no longer coincide with the orientation of the bajir depressions, the lakes are probably often framed about by old marginal ramparts built up by the river at still older stages of its existence. Accordingly these lakes belong to a more transient and more undecided type of lacustrine formation than do the Avullu-Tajek-Arka-köl series.

If now the lakes last named are situated, as I have proved, in former bajir depressions, the question arises, why is it that these depressions are deepest just in this part of the desert? In other words, why is it that a trench or hollow runs right across the desert all the way from Lop-nor to the vicinity of these lakes, a trench that is moreover parallel to the line of the Kara-buran, the lowermost Tarim, and the Kara-koschun? Presumably the reason is, that during the time the Tarim flowed along the bed of the Kuruk-darja, it was just the bajir depressions in the very middle of the desert that were most developed, possibly because the wind there, midway between the Kuruk-tagh and the Astin-tagh, put forth its greatest energy.

The existence of these typical bajir depressions affords a very strong, although I admit an indirect, proof, that, during a pretty long time, this part of the Desert of Lop at any rate was entirely free from water, and the modulation of the surface is due to no other factor but the predominant wind. In the Desert of Tschertschen we were able to convince ourselves that bajir depressions can only originate in a sandy desert, and that consequently each individual bajir is fenced in on west and east by a long ridge of sand. Accordingly it is quite natural that, if we proceed east from the vicinity of Avullu-köl, we find the bajirs decrease in size proportionally with the diminution in the volume of the sand, until finally they disappear, even as the sand does. The parts of the Desert of Lop which I crossed exhibit not the slightest trace of meridional bajir grooving, except that which runs from north-east to south-west, and is a direct consequence of the erosive action of the wind.

I have also assumed, that the prevailing east-north-east wind, which is so typical of the Lop country, grows increasingly less constant towards the west. All the same it is impossible to overlook the situation and direction of the Chotan-darja and the Kerija-darja. Both these rivers flow parallel to the chain of bajirs through which I marched in the Desert of Tschertschen; and although their courses are determined by the trough-like basin of East Turkestan, it is not impossible that they may also have been to some extent influenced by the relief and configuration of the desert itself. The lines of fall, which they suggest, taken together with those of the Jarkent-darja and the Kaschgar-darja, form, like the similar lines of the bajir depressions in the Desert of Lop, the radii of a circle, although in this instance the orientation is more excentric. The north-north-west direction of the Nija-darja, Tolan-chodscha, Bostan-toghrak, Möldscha, and Kara-muran agrees perfectly with the position of the depressions in the southern part of the desert. For instance, if the Bostan-toghrak carried a sufficient quantity of water to be able to flow all the way to the

Tarim, its lower course would to a dead certainty incline successively towards the north, north-north-east, and north-east, and would consequently form an arc of approximately the same shape as that described by my itinerary through the Desert of Tschertschen (Pl. 38).

The circumstance that, during the scanty thirty years in which the Kara-koschun has been known to Europeans, it has been constantly shrinking, an omen, as some opine, of its speedy total disappearance — this circumstance in no way proves that the terminal basin of the Tarim has been uninterruptedly growing less and less right down from the earliest times of which the Chinese annals speak. No inference can be drawn from the nomenclature of the Chinese records; for, while some of the names terminate in the equivalent for »sea , others indicate a »marsh», e. g. Lôu-lan-hai (the Lôu-lan Sea) and Jen-tsö (the Salt Marsh). The dimensions, 200 li long and 100 li broad, suggest on the other hand a very small lake. All the lakes of Central Asia are undergoing a process of desiccation, although the process has of course reached different stages in different types of lake. While, for instance, the Baghrasch-köl and the Issik-köl are hardly likely, for a long time to come, to undergo any appreciable alteration in either form or extent, it is quite easy to trace the amount of shrinkage which the Sea of Aral or the Lake of Balkasch has undergone within a pretty recent period. But the Lop-nor-and-Kara-koschun forms such a peculiar exception both in regard to geographical situation and hydrographical relations, that no comparison can be instituted between this migratory lake and any of its neighbours. For one thing, its sources are distributed over such a vast area and occur in such widely diversified regions as northern and western Tibet, the eastern Pamirs, and the southern Tien-schan, and for another thing the terminal basin is situated at such an immense distance from all its headwaters. I have already alluded to the stupendous changes which took place during the later geological epochs in connection with the Central Asian Mediterranean, and its final complete disappearance; but within historical times, with which alone we are here concerned, that is at the most a period of 2.000 years, we can hardly suppose that any very great climatic changes have taken place within the basin of the Tarim or its catchment area. Dr. Nils Ekholm has personally suggested to me, that the encroachment of the peripheral regions upon the central territory, or in other words the forward movement of the water-partings towards the central parts of the continent, may be at any rate one of the causes of the desiccation of the Tibetan lakes. If this theory is sound, the continued erosion of the head-feeders of the Tarim would tend to push back the water-partings outwards towards the periphery, and consequently to enlarge the drainage-area of the Tarim system, the effect of which would be the direct opposite of that which actually takes place, that is to say the terminal lake would increase in area. In any case however a change that is dependent upon the displacement of the water-parting is a geological phenomenon, and consequently lies entirely beyond the control of historical criteria.

If we except the Kerija-darja, it cannot be said that the rivers of East Turkestan carry any smaller volumes now than they did 2.000 years ago. According to Stein, the river I have mentioned reached the Tarim as late as the 16th century. But, one cannot help asking, can such great climatic changes have taken place within its catchment area in the course of 300 to 400 years for the river to have dried up in the sand 132 km. distant from the Tarim? It is not very probable.* Another cause, or rather several other causes, must be found for this stream having been cut off from the main river. It may in part be due to the fact that during the 300 to 400 years in question the oasis of Kerija has been more densely inhabited. Another contributing circumstance may be the forest, and the belt of vegetation which is spreading along its banks, setting up a greater drain upon its volume, though on the other hand the increased shade and the generally moister surroundings will have tended to augment the river's power of resistance to drought as compared with the time when these forests were scantier. Finally, it may also be ascribed to the extension of the sandy desert and the increase in the amount of sand, resulting in the choking of the northernmost reaches of the stream; or rather in compelling it to take an underground course, an inference suggested by the presence of groups of fresh poplars along the north-north-east prolongation of the river. To these there have of course to be added certain climatic factors, at any rate in part; though what their real nature is we know but little.

Fig. 172. THICK FOREST AT KATAK, CAMP XIX, KERIJA-DARJA, 1896.

Perhaps the same forces have affected the Chotan-darja. Anyway, it would be difficult to prove that the rivers of East Turkestan have on the whole suffered any diminution of volume. Nor is there in the course of the year any great difference between the absolute maximum volume and the absolute minimum volume in the lowermost Tarim, for its waters are gathered from so many regions, separated from one another by such vast distances, that the varying amounts of precipitation which fall over this immense area doubtless counterbalance one another, so that the final amount will be pretty constant, that is in so far as these regions are not subject to the oscillations of the »Brückner periods«. The Kontsche-darja in particular is remarkable for the constancy of its volume; indeed this is to only a slight degree affected by the amount of precipitation that falls within its catchment area (unless the departures from the normal are spread over especially long periods), as also but slightly too by the annual formation of ice and its subsequent spring thawing.

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* In a note to p. 79 of Vol. I. I have expressed a different opinion as to the Kerija-darja. But now, after having studied the problem more thoroughly, I find the opinion expressed above more likely.

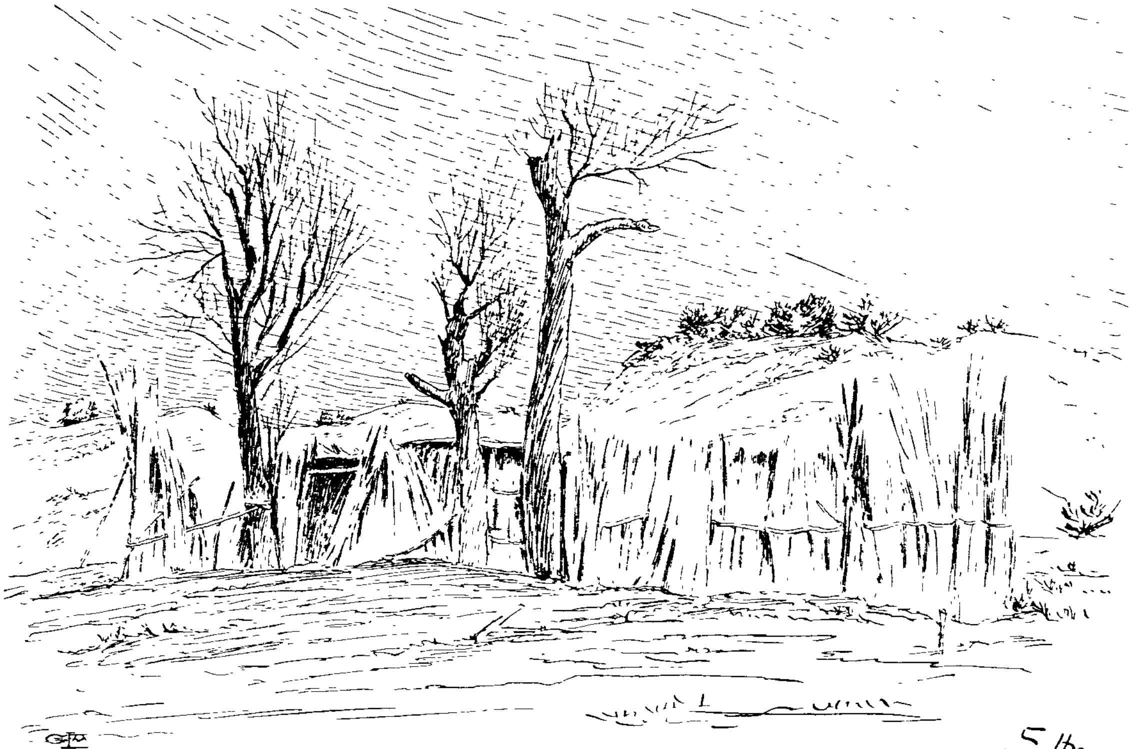

Fig. 173. SAND-DUNES BOUND BY VEGETATION, AT KULATSCHA: KERIJA-DARJA.

All this goes to show that the terminal basin of the Tarim system must maintain a pretty constant area; at all events its waxing and waning only admit of being observed after the lapse of a considerable interval of time. So far forth therefore this lake is more advantageously circumstanced than, say, Lake Balkasch or the Ala-kul; though less advantageously than the Baghrasch-köl, which as it were stores up its water from year to year, while in addition to this its position never changes owing to the steep gradients of the »stream-line«* between the equidistant contour lines of its trough-shaped basin.

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* »Stream-line« is the scientific term for the perpendicular between two contour lines.

Notwithstanding the probable correctness of all these theoretical speculations, we know that the existence of the terminal basin of the Tarim system (disregarding its situation) is extremely precarious, and that the lake shrinks so rapidly that even in the short period of no more than four years the diminution is distinctly perceptible. The causes of these oscillations are not however to be sought for in the wide circle of feeding-areas from which the water is gathered into the Tarim, but they are inherent in the immense central basin of the desert itself, which the Tarim and its tributaries traverse both lengthwise and transversely, and in the course of which their originally pretty constant volumes, far from being augmented, are on the contrary drawn upon nearly all the way down. Of course I do not mean to deny that the great climatic anomalies, which may obtain throughout the whole of Central Asia, may also make their influence felt upon both the volume and the extent of the Kara-koschun; for it is evident, that an unusually snowy winter and spring must not only give rise to an active thaw in the early summer, followed by an exceptional rise in the volume of the river, but larger quantities than usual of excess or overplus water will contrive to find their way down to the lake. And even though the amount of the winter precipitation is small, there is still always a great deal of snow left from the preceding year in the source regions above the limits of perpetual snow, so that large volumes of water invariably flow down to these rivers, to say nothing of the many thousand springs scattered throughout the mountains, all of which, taken together, add an almost unchanging tribute to the flood that fills the bed of the Tarim. But to this question I shall have to return when I take a general survey of the whole of the Tarim system.

Nor would I for one moment attempt to deny, that the volume of the Kara-koschun is appreciably affected by the temperature and wind relations in East Turkestan itself. An unusually hot summer, accompanied by an active circulation of the atmosphere, increases the evaporation over the whole course of the river. If now the various factors that are operative in the various regional divisons of the basin happen to be simultaneously active, the resultant effects are naturally very evident; though it must of course be extremely seldom that such a remarkable conjuncture occurs. When, as more usually happens, the one contributory factor is operative in one region and another factor in another, the ultimate outcome is, that the resultant effects remain pretty constant; and we do know for certain that the terminal lake has been in existence for at least 2,000 years.

# CHAPTER XXIV.

## FACTORS TENDING TO DECREASE THE VOLUME OF THE TARIM — MIGRATIONS OF THE LOP-NOR.

It is not however upon these climatic oscillations that I wish to dwell, but rather upon the oscillations which actually came under my own observation; their causes are not only more patent, but more intimately associated with the desert that the river actually flows through than with the source regions which encircle it. I now proceed to consider three factors which in a greater or less degree act as a drain upon the volume: they are (1) artificial irrigation; (2) the splitting of the Tarim into several deltaic arms; and (3) the creation of marginal lakes.

The shrinking of the Kara-koschun did not escape the observation of Prince Henri d'Orléans, when he visited the lake in 1889, a circumstance which he attributed to the drain of irrigation works. He says: »Depuis une dizaine d'années, le Turkestan chinois, qui était auparavant le théâtre de guerres civiles continuelles, semble pacifié, du moins pour un temps; les habitants profitent de cette trêve pour se livrer à des cultures auxquelles ils avaient dû renoncer pendant longtemps. Pour arroser leurs champs, ils détournent une partie des eaux du Tarim, qui se perdent ainsi en irrigations, ou en inondations artificielles; les cultures qui, comme celle du riz, demandent beaucoup d'humidité, tendent à prendre chaque jour une plus grande extension, et, par là, à diminuer de beaucoup l'apport du Tarim au Lob Nor.« *

My former visit in East Turkestan led me to doubt very much whether irrigation did exercise such a great influence as to make its effects distinguishable in the volume of the Kara-koschun. For, even though almost the entire flood which descends the Jarkent-darja in spring were to be forced by dams to flow to the cultivated fields of Maral-baschi, the loss is relatively insignificant when compared with the immense volumes of water that, during the early summer and the height of that same season, flow unchecked down the Tarim to its terminal lake. And the amount which the Ak-su-darja loses through a similar cause is still smaller. Nevertheless it cannot be denied, that all the water which is used for irrigation purposes at Tschertschen, Chotan, Jarkent, Kaschgar, Utsch-turfan, Ak-su, Baj, Korla, and even in the

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* G. Bonvalet, *De Paris au Tonkin à travers le Tibet Inconnu*, p. 101.

Lop country does swell up to a very appreciable amount, and that this does to a certain extent represent a drain upon the Kara-koschun. The Kaschgar-darja is distinctly an insignificant stream, and is barely able to get all the way down to the Jarkent-darja, but its feeble flood is still further weakened by the tribute it yields to the irrigation canals. The Kontsche-darja is not only drained for irrigation purposes below Korla, but also suffers loss through evaporation, through marginal lakes, and through absorption into the ground, so that less than fifty per cent of its volume succeeds in reaching the Tarim. Tschertschen is so thinly inhabited that the amount of water which is there appropriated for economic purposes is relatively small.

On the other hand I do not believe that the shrinkage which has taken place in the Kara-koschun during the last 30 years is to be attributed to any spread of agriculture, for even though there has been an expansion under the conditions of peace which now prevail, any effects that expansion would produce upon the volume of the Tarim would disappear in the fluctuations of the spring floods. Nor may we assume it as certain, that the shrinkage of the terminal lake has been going on for 2000 years, the cause being the gradual increase of the population during that period. On the contrary it seems more likely that at an earlier date the population was more numerous than it is now; and as evidence of this I may point to the ruins of the numerous towns and villages which have been abandoned because they were threatened by the continuous encroachments of the sandy desert, and eventually were overwhelmed by it. If irrigation really has exercised any effect upon the dimensions of the terminal lake, the inference is suggested, that the consequence of the more extensive irrigation of the oases in former times must have been to reduce the terminal lake to an even smaller area than that it possesses now. And it is possible that such really was the case, if we may build upon the unexpectedly small dimensions which the Chinese geographers assign to the Lop-nor. For there cannot exist a doubt, that the expansion of the sandy desert, the creation of marginal lakes, and the division of the lower part of the river system into several arms have, within historic times, been the worst enemies of the terminal lake, forcibly reducing it in area; but the combined result of these effects has been entirely neutralised by the inverse enlargement of desert area which has ensued in consequence of the decrease in population. The general result has however undoubtedly been this, that the terminal lake has retained approximately the same dimensions from the time of the earliest Chinese maps right down to the present moment, allowance being of course made for the climatic oscillations, for which that lake, in virtue of the excessive shallowness of its basin, must in an especial manner have been sensitive.

Let us turn now to the second factor which exercises a detrimental effect upon the volume of the lowermost Tarim. To judge from the historical as well as from the geographical *facta* (e. g. the Kuruk-darja), the Tarim during some past epoch flowed into the Lop-nor through one single bed. At the present time however it splits up, not far below Jangi-köl, into a number of different arms, first one and then the other serving as the main channel. In the latitude of Kara-köl these various arms form a complicated network of anastomosing branches, and it is not until we get down to Schirge-tschapghan that they are all gathered again into a single channel; but even at this last-named point a final bifurcation takes place, in that the Tokus-tarim breaks away from the main stream and makes its way independently into the Kara-koschun. It is evident, that a river which divides and subdivides in this way into a number of arms must lose a vast quantity of water, not only in consequence of the greater evaporation surface it thus presents, but also in consequence of the absorption into the ground which must inevitably take place in and through the existence of so many new channels. The alluvial deposits which the river lays down tend more and more to level up the Desert of Lop and make its surface more uniformly horizontal. And parallel with this marches the tendency which the Tarim shows to split up into an increasing number of arms. So long as its basin was less full of sediment than it is now, and consequently the gradients of its fall were more decided, the Tarim made its way to the Lop-nor by the steepest slope, that is the shortest »stream-line», and as a consequence confined itself to a single channel. At the present time it has attained a sort of intermediate phase in its existence; for, while it is divided into a great number of arms, it also follows at the same time a certain dominating direction of fall. The next phase will no doubt be, that it will break up into an even greater number of arms, which will all follow their own separate paths into the terminal lake. This development, which would reduce the river to an even yet greater degree, will only hold good so long as its lowermost course occupies its present position. For, if the quantities of alluvium which are deposited every year in the existing Tarim delta should eventually force that river, together with its tributary the Kontsche-darja, to return to the Kuruk-darja and the Lop-nor, it is very probable that it would do as it did before, and confine itself to a single main channel, and as a consequence of so doing would augment considerably in volume. And in the light of the knowledge we now possess, as to the relations of level that obtain in the Desert of Lop, it is not too bold a thing to say, that some time the river *must* go back to the Kuruk-darja. The country between Tikenlik and Tschigelik-uj is more exposed to the wind-driven drift-sand than the regions to the north and to the south of it. And I have already had occasion to call attention to the immense masses of sand which are carried down into the delta of the Tarim in consequence of the pressure which this river exercises upon the north-east face of the Desert of Tschertschen. It is merely a question of time, but the country hereabouts will become so choked with alluvia that the river will be forced to return to its northern bed. The lowermost limb of the river thus oscillates backwards and forwards like a pendulum, and even though the periodic time of each oscillation does amount to 1500 years, yet that, counted by the clock of geologic time, is relatively of no longer duration than one of our seconds. The circumstance suggests a comparison with the pendulum-like oscillations of the lowest part of the Hwang-ho. No direct comparison can be instituted between the two streams, because the Chinese river was forcibly constrained to abide in the course which it followed from 1290 to 1852, until in the latter year it burst its bounds and took the more southerly course, though shortly afterwards it was again forced back into its ancient bed farther to the north. In the case of the Tarim Nature is her own regulator, and the population is too small to prevent a catastrophe from happening, or when such does happen, to hinder it from being very disastrous. At the time of my last visit the river exhibited a decided tendency to follow a more easterly course; for the westernmost branch, the main stream of the Tarim, had become filled with mud and precipitated sand to such a degree that its channel was contracted to the merest ribbon, and in fact for long stretches was altogether abandoned. On the other hand the Laschin-darja and the eastern Ilek had very greatly increased in volume. This is no doubt a purely local oscillation, with a brief periodic time, but it involves the beginnings of a greater restlessness and instability. The Chinese did, it is true, talk about trying to put down dams and piles, and so forcing the river to keep within its old course, because its threatened desertion would be injurious to certain villages and communities, and fatal to their fields, all alike dependent upon its remaining true to its original course; but their labour would be wholly in vain, and would be rendered nugatory by Nature's own arrangements.

The reason of the river having deserted its ancient bed, the Kuruk-darja, and made a new path for itself south-eastwards through the Desert of Lop is of course the same as that already alluded to, namely the excessive accumulation of sediment.

The third factor which at the present day tends to weaken the Tarim is the creation of marginal lakes. I allude only to the lakes which occur below Karaul, for above that great bend the river is relatively more constant to its bed, and its marginal lakes are less changeable in both number and area, if not indeed in situation as well.

At the time of Prschevalskij's visits the bed of the Ilek and the basin of the eastern lakes did indeed exist, but they happened at that moment to be dry; accordingly we do not find any indication of them on Prschevalskij's maps, and the information afforded by the natives is in full agreement with these facts. At that period all the water of the Tarim and the Kontsche-darja was collected at Arghan. When the water again returned to the eastern line — the Ilek, Avullu-köl, etc., — the greatly enhanced evaporation thereby occasioned robbed the river of a large part of its former influx. In proportion as the Kara-köl lakes became filled, so did the Kara-koschun dwindle.

But an even more powerful influence is exercised upon the volume of the Kara-koschun by the 35 marginal lakes that are strung along the right bank of the Tarim below Karaul. I have already dealt with them in detail in volume I, p. 300, and may therefore dismiss them here somewhat summarily. We calculated that, if all these lake-basins were empty, and if the Tarim carried a volume of 66 cub. m. in the second, as it did at Jangi-köl on 16th May 1900, it would take a flood of that magnitude a period of 468 days and nights to fill the lakes in question. We also calculated that, if in the course of a year these lakes lost on an average a layer of water 1 m. in depth through evaporation and similar causes, the aggregate loss would represent a volume of 564 million cubic meters, and that, to make good this loss, as well as to preserve the lakes at the level at which we found them, it would be necessary for the entire volume of the river, amounting to 66 cub. m. in the second, to empty itself into the lakes in question without any diminution for a period of 99 days. In round figures we estimated, that the loss which these lakes inflict annually upon the Tarim amounts to one-fourth of its volume, or in other words that the creation of these lakes diminishes the mean volume of the Kara-koschun by one-fourth. The course which the Tarim follows in the vicinity of these lakes was proved to be of relatively recent date; and before these lakes originated the Kara-koschun was therefore one-fourth bigger than it is now. If now the river maintains its present course, to even a moderate extent, unaltered, and thus enjoys an opportunity of going on building up its containing ramparts undisturbed, its surface will eventually rise higher and higher above the desert depressions, and these again will in their turn make bigger and bigger demands upon the Tarim for water to fill their basins. If however the Tarim, both in this part of its course and lower down as well, moves farther to the east — and this is what will very likely happen — then these marginal lakes will cease to exist, and the Kara-koschun will consequently expand and enlarge its area.

Hence the oscillations in the lake are entirely dependent upon chance hydrographical changes: but it would be a grave mistake to attempt to harmonise these periodical variations either with the Brückner periods or with any other secular climatic changes in Central Asia. The diminution of the Kara-koschun is simply and solely the reciprocal effect of the origination of the marginal lakes higher up the river.

But if these marginal lakes diminish the Kara-koschun to the extent of one-fourth, and the Kara-köl lakes likewise exercise a considerable drain upon the river, it might be expected that the Kara-koschun would have undergone a more appreciable and more extensive diminution than what actually has been the case. But as against this, there is the probability that other marginal lakes and lagoons, which were in existence at an earlier period, have in process of time become filled up and been abandoned. This has happened, for instance, in the case of the Kara-buran, which, according to Prschevalskij's map of 1877, had an area equal to one-third that of the Kara-koschun, but since that time it has shrunk to quite a small temporary sheet of water, which disappears entirely in the summer. The extinction of this lake has had a diametrically opposite effect to that produced by the origination of the marginal lakes; this and the great area to which the Kara-buran extended less than 30 years ago have contributed to make the drain of the Kara-koschun less noticeable than it otherwise would be. In the case of the oscillations therefore that owe their occurrence to more local causes the cooperating factors to some extent counterbalance one another. At the present time however the northern marginal lakes have such a decided preponderance, that the Kara-koschun has as an actual fact during the last decennia shrunk very considerably.

These arguments and conclusions prove those, who believe that the Kara-koschun is a last lingering remnant of a gigantic lake which once filled the triangle between the Kuruk-tagh, the lower Tarim, and the Astin-tagh as late as the 3rd and 4th centuries, to be absolutely wrong, for the view they advocate exhibits a defective knowledge of the hydrographical and hypsometrical relations in the Lop country. Radical changes and alterations of the kind they point to transcend entirely the historical reckoning and belong to the domain of geological computation.

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I will now proceed to discuss the theory which seems to me to explain the causes of the migrations of the lake of Lop-nor. From the very nature of the case the causes in question, excepting only the effects due to fluvial sediment and the uniform horizontality of the country, must be of a quite different character from those that are operative in the lower Tarim. For if the Kara-koschun occupied an actual depression, with sharply defined boundaries, it is self-evident that the lake would be immovable, no matter how greatly the river altered its course. But in actual fact there exists no cavity, no distinct basin; the country is almost everywhere a dead flat, and this is of course the fundamental reason why the lake *is able* to alter its position at all.

Let us first consider the effect which the Kara-buran may have upon the basin of the Kara-koschun. According to Prschevalskij, the first-named lake was in 1877 30 to 35 versts long and 10 to 12 versts broad, but even then its extent varied considerably according as the Tarim was at high water or at low water. The lake was 3 to 4 feet deep or less, though there were some deeper places. The open reed-free reaches were both more numerous and more general than those in the Kara-koschun. With regard to the Kara-koschun he says, »This lake or more strictly speaking this marsh» is 90 to 100 versts long and at the most 20 versts broad. This measurement does not however agree with his own map,* which represents the Kara-koschun as being only three times as large as the Kara-buran. But it is quite evident from the description as well as from the map that the last-named lake was at that time a really extensive sheet of water. According to the same map the circumference of the lake, disregarding capes and bays, was 85 versts. Pjevtsoff in 1890 estimated it at 60 versts. If we may assume that both these measurements refer to the lake at the period of high water, they clearly indicate a not inconsiderable diminution in its dimensions during the interval of 13 years. Within the next six years following the lake experienced a very much greater shrinkage, as my map of 1896 plainly shows, for at a time of year when the former lake-basin of the Kara-buran ought to have been full of water from the melting of the ice I was able to ride diagonally across it. And in 1900 in the beginning of June the lake had practically disappeared, nor would the ensuing autumn flood fill more than small portions of its old basin. The insignificant remnant that survived was converted into a marginal lake hanging upon the new (at any rate in that region entirely new) bed of the Tarim, in striking contrast to the situation of 1877, when the river both entered the lake, and flowed out of it again at its eastern end.

What has filled up the lake is the sediment that the Tarim and the Tschertschen-darja have brought down with them and deposited in its basin. In 1890 Pjevtsoff was able to say, »In the western part of the lake we encountered numerous sheets of open water, fresh and exceptionally transparent, and measuring as much as 8 versts in circuit and 4 saschen in depth.» This last statement is however one which I can only accept with the very greatest dubiety — namely that a lake of such excessive shallowness should increase from a depth of 3 to 4 feet in 1877 to not less than 28 feet in 1890. Anyway these large basins, filled with bright, clear water, have within the last ten years become loaded with sediment.

During the period in which the conditions remained thus the Kara-buran acted as a clearing-reservoir for the Kara-koschun, and hence contributed in an exceptionally high degree to the preservation of the last-mentioned lake. On Prschevalskij's map the connecting link between the two lakes is only 20 versts long, and in that short distance the river had no opportunity to pick up any notable quantity of sedimentary matter. The water upon issuing from the upper lake was perfectly clear, and the erosion of the bed was in no case more than insignificant; indeed it was confined to the sides, though they again are tolerably well protected by vegetation. Consequently upon reaching Kum-tschapghan the water was but very slightly muddied, and at the present day the maximum depth of the Kara-koschun is sounded in its western part, though that quarter is also at the same time much less exposed to be filled up with drift-sand than the eastern part.

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* *Karta Lob-nora po sjomke Polkovnika Prschevalskago v 1877 godu.*

The sedimentary masses of the Tarim were thus employed, in the time when the Kara-buran still existed, partly to fill up this lake, partly to build up the pier-like ramparts which now form, and will also continue to form in the future, the framework and containing banks of the river. In consequence of this the sediment with which the river is charged is carried on past these enclosing margins, and the water, upon reaching Kum-tschapghan, is not only incomparably less turbid, but contributes to fill up the basin of the Kara-koschun at a greatly increased ratio. Now that the Kara-buran has for the most part disappeared, the fate of the terminal lake is sealed, and it is only a question of time for it to follow the example of its sister lake.

It is very interesting to note the unambiguous parallelism which has characterised the changes that have taken place in the two lakes during the last decennia. The shrinkage of the Kara-buran has entailed a similar diminution in the Kara-koschun, and the disappearance of the former would now seem to entail as a necessary consequence the disappearance of the latter. One is indeed strongly tempted to believe, that the disappearance of the Kara-buran is the reason why the terminal lake has become restless and has begun to travel; but that would be «the last drop that makes the cup run over». On the other hand the Kara-buran appears to be less intimately connected than the Kara-koschun with the upper marginal lakes, for the consequence of the creation of these upper lakes has been a diminution in the volume of the lower Tarim, entailing as a further consequence a decrease in its power to carry sediment in suspension, to say nothing of the clarifying process the water undergoes in the course of its passage through all these upper lakes. At the same time, as an even further consequence of the same course, the filling up of the Kara-buran has been rather checked.

I possess no sure data which would enable me to calculate, even approximately, how long a time would be required to fill up completely the basin of the Kara-koschun with solid material. Before any such calculation could be made, it would be necessary to carry on investigations, extending over at least one year, into the capacity of the river to carry sediment. I have already stated that 2000 million cubic meters is the volume, or rather the capacity, of the Kara-koschun at the beginning of April, and that total is too high rather than too low. I have also assumed, that the whole of that volume is lost every year, especially through evaporation; and if the lake is to be maintained at its normal level, it must be fed by an average inflow of 64 cub. m. per second all through the year. If we take it, that every 20,000 cub. m. of water carry in suspension one cub. m. of sediment, it would take exactly 1000 years to fill the basin of the Kara-koschun with sediment. I should suppose that the effects of the drift-sand and drift-dust are at least equally as powerful. On the assumption therefore, that the two factors cooperate simultaneously, the basin would be completely filled in 500 years. Add to these the third factor, which is of an organic character, namely the contribution which is made towards the filling up of the basin by the incredibly dense kamisch. For the reeds not only arrest the drifting sand and dust, they also bind it together and compel it to sink to the bottom, so that one way or another the amount of matter which the decaying and rotting kamisch must contribute towards the filling of the lake must be immense.* In

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* Even on my first visit to the Kara-koschun in 1896 I was struck by the indisputable fact, that the dense reeds, which even then covered nine-tenths of the area of the marsh, and were in most places absolutely impenetrable to a canoe, must in a very high degree contribute to the filling up of the lake-basin, not only in consequence of the decaying vegetation they deposit directly, but also indirectly through their power of arresting sand and dust. These results must indeed follow everywhere where a shallow lake is full of reeds and the atmosphere is heavily charged with loess-forming material. This is the conclusion to which J. Walther also arrives, for he says: »Wo ein Wustenstrom im trockenen Delta versiegt oder in einen Binnensee mundet, da hilft die üppige Schilfvegetation in bedeutungsvoller Weise mit, um die Mächtigkeit der Sedimente zu erhöhen. Das schilfbewachsene Delta des Amu-darja im Aralsee fangt die riesige Masse der schlammigen Flusstrube vollkommen auf und bildet in jedem Jahr einen Zuwachs des Landes um 45 Milliarden Kubikmeter.« In another place the same authority says: »Die ausgedehnten Schilfbestände, welche an den Ufern grösserer Wustenflüsse und besonders im Mundungsgebiet derselben die Wasserflächen uberziehen, spielen ebenfalls eine gewisse Rolle, indem ihre vermodernden Reste den Schlamm bituminös verfarben, ja sogar kohlige Zwischenlager bilden konnen. — Ungeheuere Schilfdickichte am Ufer des Amu-darja und an dessen Delta im Aralsee bilden grosse Mengen von Pflanzenmoder, der sich lithogenetisch durch den Mangel an fossilen Stämmen besonders auszeichnen dürfte.» (Johannes Walther, *Gesetz der Wüstenbildung*, pp. 83 and 117).

When we call to mind that Richthofen discovered loess formations extending to 2000 feet in thickness, all formed from æolian dust, we are tempted to say, that the material which is dropped from the atmosphere would alone be sufficient to fill up a basin such as the Kara-koschun within a relatively short period. Even though it contained no water, but merely formed a dry depression, as full of reeds as it is now, it would become choked with loess deposits far quicker than the bare surfaces around, and those deposits would exhibit the same vertical structure as is shown in the Chinese loess deposits, caused by vegetation growing at increasingly higher levels as the ground becomes elevated. In point of fact it is a combination of sedimentary formation and loess formation in water that is threatening to fill the Kara-koschun. In its case however the vertical structure will be conspicuous by its absence, because the dead and decayed vegetation sinks to the bottom and forms horizontal layers of a bituminous character. The difference between aqueous and atmospheric deposits is quite evident from the following quotation from Richthofen: —

»Bei Sand und Thon, wie bei festgewordenem Sandstein und Schieferthon, sind die einzelnen Lagen des Materials, wie sie sich im Wasser successiv abgesetzt haben, durch ebene und untereinander mehr oder weniger parallele Flachen getrennt, welche in der Regel einer periodischen Änderung des abgesetzten Materials ihre Entstehung verdanken und eine mehr oder minder leichte Loslösung der einzelnen Lagen des Gesteins oder der Bodenart gestatten. Wo Sand und Thon zusammen vorkommen, treten sie deshalb zwar in einzelnen Schichten als homogene Gemenge auf, aber in anderen waltet entweder Sand oder Thon vor . . . Im Loss jedoch, obgleich er aus Thon und Sand besteht, kommen diese Substanzen in ganz homogener Verteilung vor. Nirgends findet sich der eine oder der andere Bestandteil in abgesonderten Lagen — — —. Wenn wir — — — genötigt sind, dem Loss die Eigenschaft der Schichtung ganzlich abzusprechen, und die Lagen fremdartigen Materials, welche seine Absonderung in Bänke veranlassen, als eine von wahrer Schichtung ganz verschiedenartige Erscheinung erklaren mussen, so werde ich doch weiter unten auch einer wirklich geschichteten Abänderung des Loss zu erwähnen haben, welche wir als See-Loss bezeichnen werden. Obgleich aus demselben Material bestehend, ist er doch von dem eigentlichen oder Land-Löss verschieden» (Richthofen, *China*, I. 61—62).

Nothwithstanding its inherent loess-forming character, and the fact that under other circumstances it would be deposited as loess layers, the dust becomes totally lost in the lacustrine sediment that settles at the bottom of this marsh, and consequently is laid down in horizontal layers, and addition Algæ and other vegetable growths, besides driftwood, all help towards the same end. Wild-duck, wild-geese, and other swimming-birds and waders, which spend there the spring, summer, and autumn by thousands together, also add their quota to the filling of the lake, and although it may not amount to much, it is nevertheless to be put on the plus side. The guano and the egg-shells they leave behind them have no doubt been derived originally from the lake, yet how many of the birds themselves die there and add their skeletons to the growing deposit at the bottom. The same remarks hold good of the fish and other animal life that the water contains. Would it therefore be too bold an assertion to make, to say that the organic contributions would shorten the period of 500 years that I have mentioned by one-half, i. e. reduce it to 250 years? Possibly it would. But from what we know, and from what we may infer as to the past history of the lake, 250 years is by no means too short a period for the lake to get filled in. For in the first place, we must bear in mind,

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these, at any rate in the eastern parts, alternate at minimal intervals with the thin layers of sand deposited by the sand-storms.

Perhaps I may be allowed to quote yet two other passages in support of the view I have set forth above, as to the necessity of assuming that the bed of the Kara-koschun is elevated at a more rapid rate than any and every other part of the Lop country. Richthofen, after calling to mind the great importance of the dust-storms that prevail, says that they: ein Sediment veranlassen, das, für jeden einzelnen Ort auf Jahre oder Jahrhunderte berechnet, einen nicht unbedeutenden Factor in der Bodenerhöhung ausmachen wurde. In anderen Ländern wird der Staub grösstenteils wieder hinweggespült; in den abflusslosen Becken bleibt der grösste Teil, durch die Vegetation festgehalten, an Ort und Stelle liegen, und trägt zum Wachsen der Steppe nach oben bei« (*China*, I, 79). — And the same view is entertained by Walther, namely that the solid material which belongs to a self-contained drainage-area has no opportunity to leave it, and further he dwells upon the rôle which the vegetation plays in binding and holding together the wind-driven dust. He says: Heftiger Wind transportiert noch Sandkorner von 2 mm. Durchmesser, in seltenen Fallen können erbsengrosse Steinchen vom Sturme getragen werden, aber dies ist auch ungefähr die äusserste Grenze fur die Wirkung der Deflation. Das Wasser kann aus einem abflusslosen Gebiet kein Stäubchen, geschweige denn einen Kieselstein, heraustragen, und so müssen notgedrungen alle gröberen klastischen Sedimente innerhalb der Wuste bleiben und dort angehäuft werden.«

»Alle mitgefuhrten Staubmassen, die sich in vielen Wirbeln über den Steppenboden wälzen, geraten hierbei zwischen das Geäste der Steppenpflanzen und fallen leicht zu Boden. Dieselben Pflanzen verhindern zugleich, dass der einmal niedergefallene Staub wieder aufgehoben wird, und so wächst die Steppe unaufhorlich durch Auflagerung feinster Staubschichten« (*Gesetz der Wüstenb.*, pp. 97 and 137.)

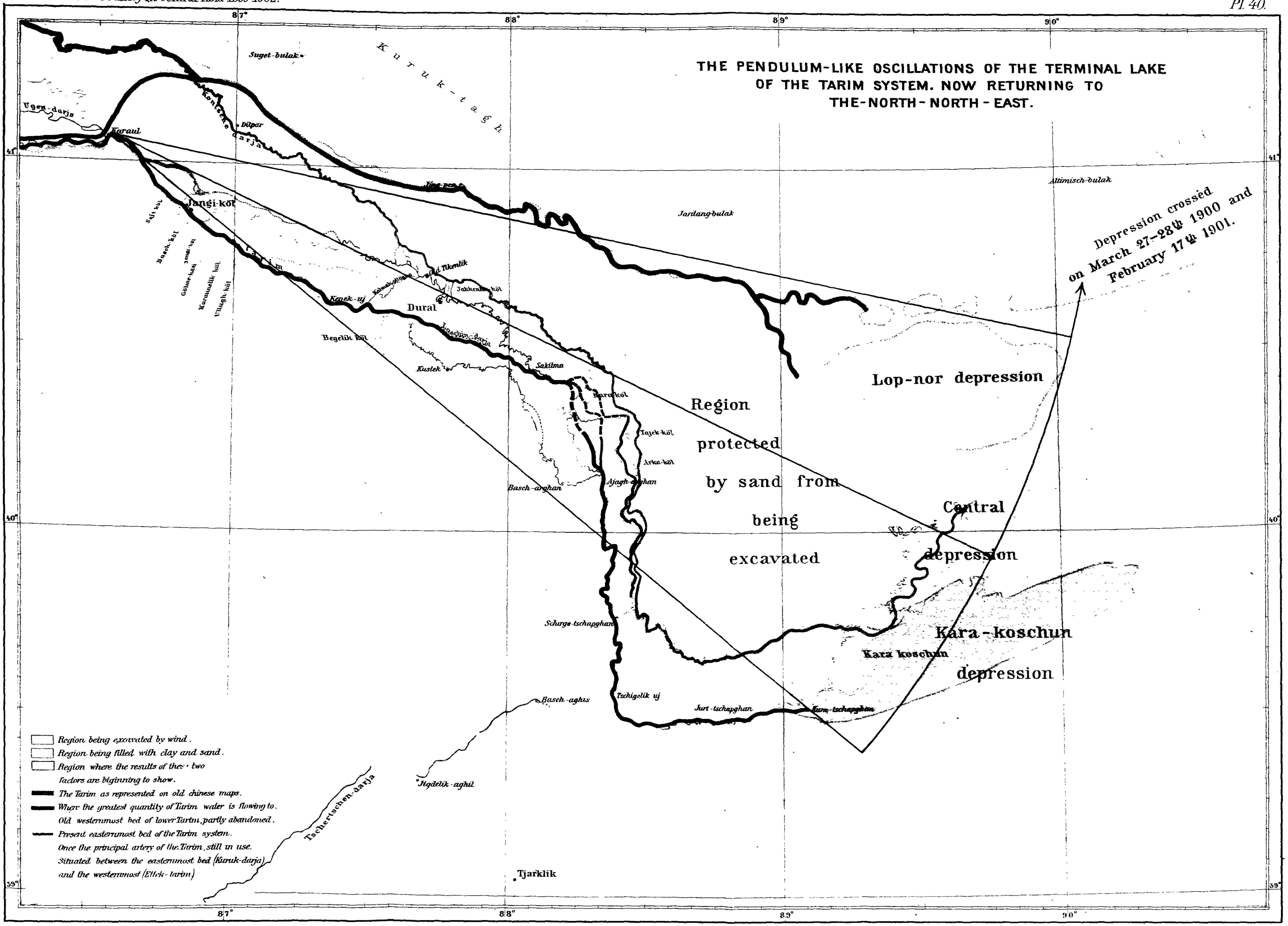
There is no need for me to emphasise in detail the extent to which the views expressed by these two investigators, in the passages just cited, are directly applicable to the basin of the Kara-koschun. And if the geographers who believe in the unchangeability of the position of the Lop-nor — supposing indeed that there are any such now left — have gone so far as to recognise that the filling of the basin is simply a question of time, it must of necessity follow that, as soon as this process is completed, and the lake-basin is full, the water will cease to flow into the former depression, for the obvious reason that this will be then full. And Walther expresses himself to the same effect: »Ist nun ein Wüstenbecken soweit mit klastischem Material zugeschuttet, dass die Unebenheiten des Bodens ausgeglichen, tiefe Mulden ausgefullt und der Boden eingeebnet ist, dann muss jede Veränderung des Wasservolumens eine sehr betrachtliche Anderung des Seeumrisses veranlassen. Meilenweit ruckt der Strand vor, grosse Flächen werden wieder trocken gelegt . . .« (*Gesetz d. Wüstenb.*, p. 116.)

The filling up of the lake and its transposition are processes that take place much more swiftly in the case of the Kara-koschun than in most other lakes, because the Desert of Lop, in virtue of its unparalleled flatness, can hardly be called a basin, at least it is not a basin in the ordinary acceptation of that term. In fact it is not a basin at all, but merely a chance and imperceptible indentation of the surface, in which the Kara-koschun lies. Supan also, following my account, published after the 1896 journey, calls the Kara-koschun a »Mundungssee«, not a »Beckensee«, and says: Dass dieser See keine selbständige Bodenvertiefung fullt, sondern einfach das Ende des Tarimflusses bildet, geht daraus hervor, dass er seichter ist als der Fluss oberhalb der Mundung; noch weit hinein ist eine fliessende Bewegung bemerkbar. Wie alle Mündungsseen ist er nach Lage, Grosse, Gestalt und Tiefe grossen Schwankungen unterworfen« (*Grundzüge der physichen Erdkunde*, p. 650.). —

that this figure has been selected from a consideration of the existing volume of the lake. and that only thirty years ago its volume was considerably greater. In the second place, we do not know how long the Kara-buran acted as a clearing-basin, and consequently we are ignorant how long it served as a check upon the filling up. Finally we have assumed on good grounds that the Kara-koschun, in its present form and in its present situation, dates from about the year 1740, and that previous to that date the river flowed through the bed of the Tokus-tarim, and not through the Kara-buran. But the value of all these theoretical calculations is to a very great extent outweighed by the observations I made with my own eyes in 1901, namely that the lake is no longer willing to remain in its present basin, but is travelling towards the north. This fact proves, with a force that renders all theory silent, that it is an utterly erroneous view to take, to suppose that the three factors I have named require a period of a couple of hundred years in which to fill up the lake-basin and expel the water from it.

And this leads us quite naturally to the question, Why is it, that the water does not remain in the basin of the Kara-koschun, seeing that its volume amounts to 2000 million cubic meters? The answer is perfectly self-evident: there are relatively deeper depressions to the north. Why did the lake not select them for its bed always, instead of, some 160 years ago or so, making its way into its existing situation? Simply because 160 years ago the present »basin« of the Kara-koschun was as a matter of fact deeper than the region to the north of it, but at the present time the situations are reversed. How then are we to explain the change that has taken place in the relative altitudes of these two quite adjacent regions? The answer to this question contains the key to the solution of the Lop-nor problem, and at the same time points out the cause of the lake's migration.

I went all round the northern and deeper depression in 1901, and found very little drift-sand there. In striking contrast to the region immediately adjacent on the east, the ground consisted of clay, furrowed by wind-groovings from north-east to south-west, and separated from each other by jardang-ridges. If we assume that, during the last 160 years, the Kara-koschun has — apart from certain changes of area — maintained the form shown by Prschevalskij, then during the whole of the period in question the clay desert to the north of it, being perfectly dry and only in part covered with sand, has been exposed to the erosive action of the wind, a very thin layer being shaved off its surface every year. And even though the layer, thus removed by the agency of corrasion, only amounts to 1 to 2 cm. in depth in the course of the year, the total result at the end of 160 years is sufficiently perceptible to make the employment of the term depression, when applied to the lowered surface, not inappropriate. In proportion as the surface has been lowered, the basin of the Kara-koschun has to a corresponding extent been gradually filled up, so that the rate at which the difference of elevation is produced is thus duplicated. Finally, it follows of necessity, that the water will leave the southern depression and seek the northern. How far the latter depression extends at the present time towards the north we do not know, but it seems very probable that it reaches all the way to the depression of the ancient Lop-nor. It is therefore probable that the newly formed desert lakes which I travelled round form a connecting link, in the shape of a broad



THE PENDULUM-LIKE OSCILLATIONS OF THE TERMINAL LAKE OF THE TARIM SYSTEM. NOW RETURNING TO THE-NORTH-NORTH-EAST.

87°
88°
89°
90°
41°
40°
39°
Suget-bulak
Kuruk-tagh
Ugen-darja
Karaul
Dilpar
KonTsche-darja
Jing-pen
Altimisch-bulak
Jardang-bulak
Jangi-köl
Salt köl
Basch-köl
Gölme-köl
Karaunelik köl
Ullugh-köl
Tarim
Kalmak-ottogho
Old Tikenlik
Jakkenda-köl
Kenek-uj
Dural
Begelik köl
Laschin-darja
Kustek
Sakilma
Kara-köl
Tajek-köl
Arka-köl
Ajagh-arghan
Basch-arghan
Region protected by sand from being excavated
Lop-nor depression
Central depression
Depression crossed on March 27-28th 1900 and February 17th 1901.
Kara-koschun depression
Kara koschun
Schirge-tschapghan
Tschigelik uj
Jurt-tschapghan
Basch-aghis
Jigdelik-aghil
Tschertschen-darja
Tjarklik
Region being excavated by wind.
Region being filled with clay and sand.
Region where the results of these two factors are biginning to show.
The Tarim as represented on old chinese maps.
Where the greatest quantity of Tarim water is flowing to. Old westernmost bed of lower Tarim, partly abandoned.
Present easternmost bed of the Tarim system. Once the principal artery of the Tarim, still in use. Situated between the easternmost bed (Kuruk-darja) and the westernmost (Ettek-tarim)

Fotolit. Gen. Stab. Lit. Anst. Stockh.

channel, between the two »communicating vessels« ; and this inference is further strengthened when we call to mind, that the lakes in question widen out in proportion as they expand towards the north, being widest close to the northern depression. But with regard to this we possess no certain information until a fresh levelling has been made. It is not inconceivable, that at the present time the deepest part of the desert exists in the middle, so that it is very possible the new lakes will there make a temporary halt, until the more northern depression of Lop-nor becomes still further deepened by the wind. The first supposition is however the more likely, especially when we compare the relations of level along this eastern line with those along the line of the Tarim, where the greatest depths coincide with the lake-region around the Kara-köl. The lake of Utschu-köl, the recollection of which is preserved by tradition, seems to have been situated somewhere about the locality in which the newly formed desert lakes are now; and this argues for the probability, not only that the terminal lake of the Tarim oscillates between the depression of the Lop-nor in the north and the depression of the Kara-koschun in the south, but also that there are sometimes intermédiate stations between the two. If the Lop-nor shifted its position in the 4th century, and if the Kara-koschun is shifting its position in the 20th, it follows that the intervening sixteen centuries are the measure of the full period which is required for a complete swing of the pendulum (the lake) from the one region to the other, disregarding intermediate stages.

The essential difference between the causes which on the one hand lead the rivers to shift their beds and on the other lead the lake to change its situation is to be discerned in this, that the former build up ramparts, raise their beds, and so are forced to overflow at some weak point or other and then spread out at the side, whereas the lake alters its position in consequence not only of the wind having grooved the surface to the south or the north of it, but also of the difference of level being increased through the tendency of the lake to become filled with solid material. It is difficult to determine how far any definite parallelism exists between the oscillatory movements of the rivers and the oscillatory movements of the lake, though several circumstances point to the existence of some such relation. When the water of the Tarim flowed along the bed of the Kuruk-darja, and consequently pushed as far north as it was able to get, the lake of Lop-nor too lay as far in that direction as it was possible for it to do. But when the Tarim struck out a diagonal line to the southern extremity of the lowland, the lake settled also in the extreme south of the desert. Between these periods came the intermediate stadium which terminated about 160 years ago; but until it did so, the water of the Tarim used to flow through the bed of the Tokus-tarim from Schirge-tschapghan to Utschu-köl, wherein we may again discern a parallelism between the river and the lake. Possibly the little arm which goes to the Märdäk-köl is also a last surviving trace of a similar intermediate stage. Finally the idea of the parallelism I have suggested derives additional support from the consideration that a few years ago the water once more began to flow through the bed of the Tokus-tarim, and appears now to be experiencing a process of augmentation, in every respect parallel with the origination and increase of the desert lakes.

Thus, in one word, the cause of the migration of the Lop-nor is the filling up of the lake with solid material and the excavation of the desert by wind erosion. The process is depicted in the accompanying illustration (fig. 174). The heavy line in the upper sketch represents a vertical section of the surface drawn from north to south at the time the Lop-nor was full of water. The prolonged line 1 shows the extent to which the lake was filled after the lapse of a certain time; while I in the lower sketch shows the amount of material which during the same period was eroded by the wind and removed off the face of the desert in the region to the south. When the stage is reached that is exhibited by the sectional lines 3—III, the Lop-nor would be for the most part filled and the Kara-koschun in relation to it would be a depression. After that the combined processes would require to be carried but very little farther before the lake would run over and flow out of the northern depression into the southern depression. The lower sketch shows in section the further continuation of the process, which repeats itself exactly, except that the respective movements take place in the reversed order; that is to say the depression of the Kara-koschun fills, while the Lop-nor depression becomes hollowed out. The sedimentary deposits of clay and sand which have in the meantime been laid down in the latter are again carried away by the wind, and this explains how the *Limnæa* shells, which for centuries, or it may be for one to two thousand years, have lain embedded in the sedimentary layers, are again brought to light by the corrasive action of the wind. In reality the process is more complicated than our illustration shows, for in it I have disregarded the possible intermediate stages that occur in the middle portions of the desert. From the description I have already given of the Desert of Lop it is plain that the lines I, II, and III will not describe perfectly regular and continuous curves; on the contrary they are exceedingly irregular. Even the line of our survey (see Pl. 36) is, as I have demonstrated, much leveller than it is in reality, because it fails to show the wind-eroded gullies. The relation which

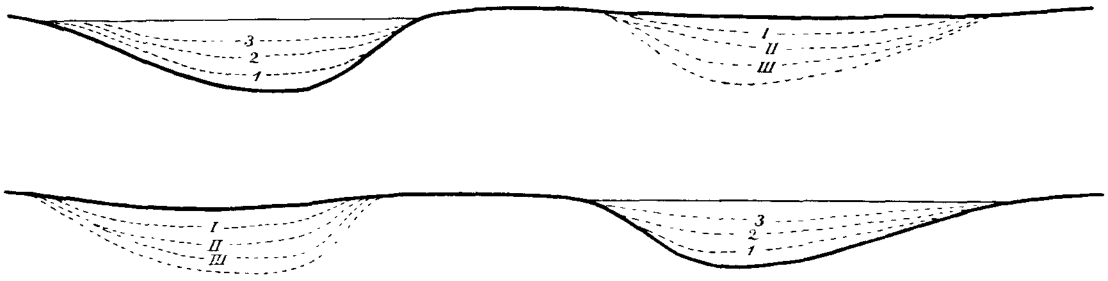


Fig. 174.

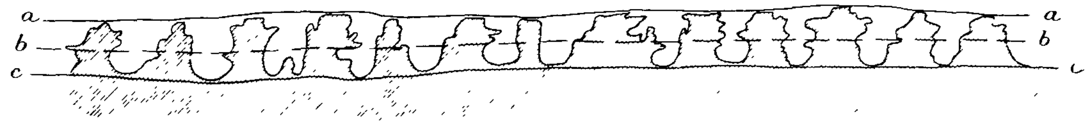


Fig. 175.

the surveyed line bears to the relief of the surface, between the beginning of the measured line and the edge of the schor desert, the section in which the wind seems to possess a relatively diminishing degree of effectiveness, that is to say along a line drawn diagonally across the actual Lop-nor depression — that relation is exhibited in *a—a* (fig. 175). Had the measured line been carried along the bottoms of the wind-eroded gullies — it would of course have been practically impossible to do so — the relation would have been as shown in *c—c*. In the former case, the levelled line fails to take account of a countless number of hollows which lie *below* it; in the latter case it fails equally to take account of a similarly incalculable number of ridges or elevations which rise *above* it. Having regard to the permanent mass of the soil, the line ought to occupy a position intermediate between *a—a* and *c—c*, namely *b—b*; but the real effects of wind-erosion can only be shown by lowering by 1 to 1½ m. the sectional line on Pl. 36 from the starting-point to the beginning of the schor desert.

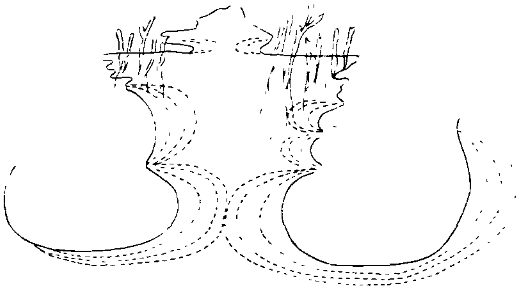


Fig. 176.

In other words, the erosive action of the wind is unequal, a circumstance I attribute to the existence of ancient vegetation. Where ancient vegetation is absent, the wind develops its full erosive power unchecked; where it is present it affords protection to the surface (see figs 62 and 64). This circumstance explains also how it is that the clay ridges are so often broken through. Notwithstanding their change of direction from north-south to east-north-east and west-south-west, a change that is apparently determined by an inclination in the paths of the winds (see Pl. 38), the clay ridges preserve an extraordinary parallelism. Nevertheless it is not certain that on the whole the presence of ancient vegetation does retard the corrasion to any very noteworthy extent, for it is probable that on the other hand the wind works with redoubled force in the gullies. Their very form and outline indicate unmistakably that an undermining process goes on, as shown in fig. 176 (and 149). The illustration is a vertical section of a clay ridge, with a wind-eroded gully on each side of it; these last are broadest where they are deepest, the minimum of resistance being offered to the wind in those places owing to the absence of vegetation and its roots. The ridge higher up is held together and consolidated by the presence of roots, and consequently it broadens out towards the top, until it resembles a flattened ridge resting upon a long narrow pedestal or base. It is in fact hollowed out on both sides in the shape of a spoon, in the way shown by the dotted lines, and consequently grows narrower and narrower (see also Pl. 27). Finally a breach is made right through it, and the upper part of the ridge falls. Precipitated fragments of this character are frequently seen lying in the gullies, where they are exposed to the concentrated pressure of the wind, and consequently are more speedily destroyed. Thus not only are the effects of the wind unequal, in that those portions of the clay surface which are free from vegetation are subjected to a quicker corrasion, but even those parts which are protected by vegetation are likewise liable to be destroyed. Hence it would be an error to suppose that the effect of the wind is solely restricted to deepening the gullies, for there exists a limit to which the depth can be carried, a limit determined by the collapse of the adjacent ridges. If the depression of the Lop-nor does not in the meantime become filled with water, all the remaining ridges that are held together by vegetation must infallibly fall, that is to say the whole of the area of the desert that is covered with vegetation will be destroyed. Even at the time of our visit, we found a relatively small number of poplar-trees still standing; most of them had already fallen. No year passes without many of them certainly giving way, and the time cannot be far distant when the last poplar will cease to offer resistance to the destructive power of the wind.

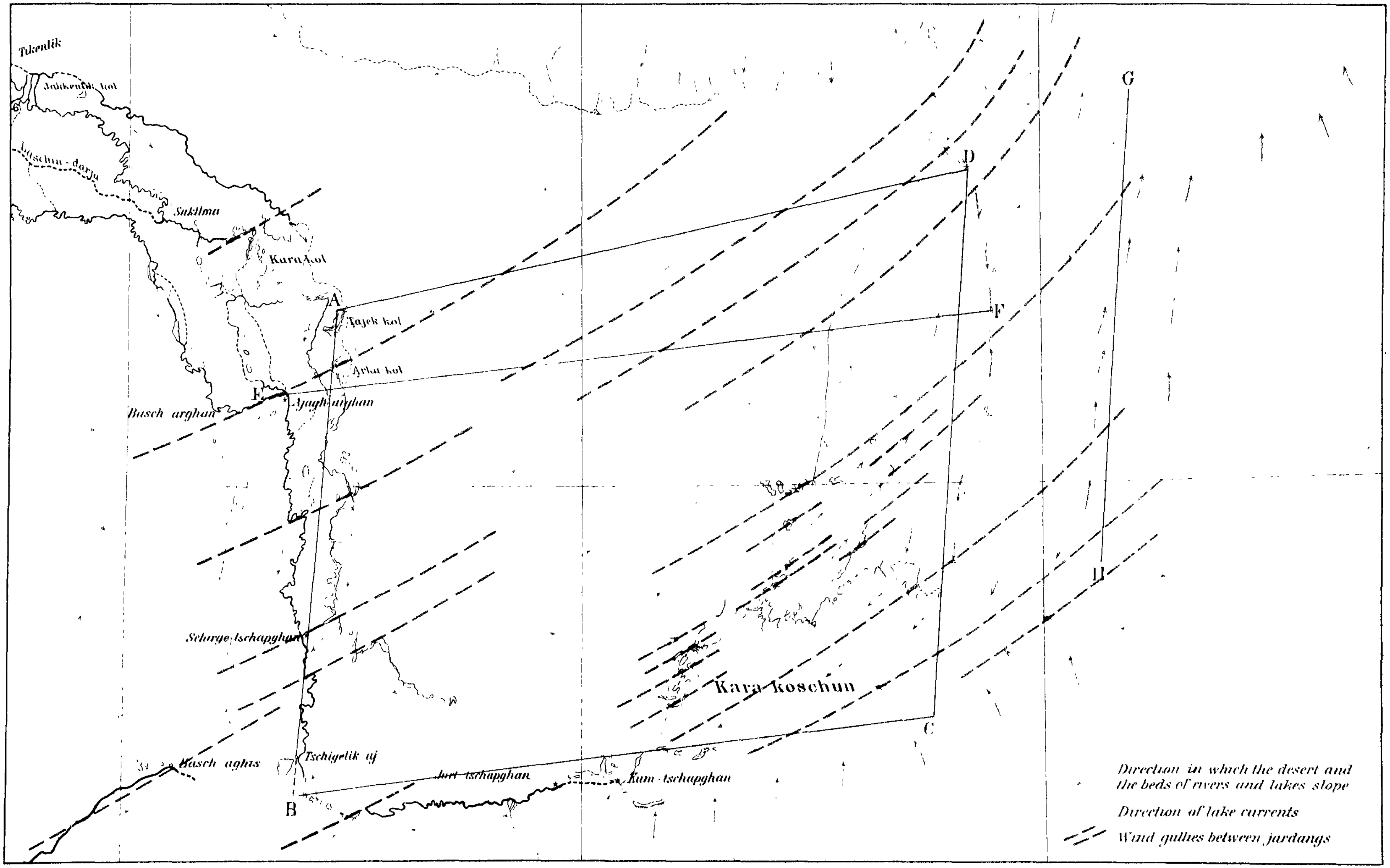
In the preceding chapters I have related the results of my investigation of the Desert of Lop, and I hope it will not be considered presumptuous if I now look upon the Lop-nor problem as having been definitively solved. Further detailed investigations in the future will of course extend our views and confirm the physico-geographical laws I have enunciated; but the materials we already possess are quite sufficient to prove that Richthofen's vindication of the accuracy of the Chinese maps is not only warranted, but perfectly correct. Nothing except a critical examination such as that I carried out can conduce to a clear understanding of the changes which have taken place; while in comparison with the information that can be gleaned by an actual study of the existing phenomena on the spot the Chinese maps lose a good deal of their value as proofs. But seeing that their testimony is in agreement with Nature herself, we are bound to render them the respect and recognition which are their due.

Before closing this chapter I should like to call attention briefly to an article entitled *The Desiccation of Eur-Asia*, which Prince Krapotkin has published in the *Geographical Journal* (June 1904), and to the interesting discussion to which it has given rise. In so doing I find it impossible to resist quoting two or three passages from this remarkable article. Even the first few sentences indicate the main features of the writer's point of view with regard to this specially important, but little studied, question. He begins:

»Recent exploration in Central Asia has yielded a considerable body of evidence, all tending to prove that the whole of that wide region is now, and has been since the beginning of historic record, in a state of rapid desiccation. At the present time, evaporation over the whole of Central Asia is very much in excess of precipitation, and the consequence is, that from year to year the limits of the deserts are extended, and it is only in the close neighbourhood of mountains, which condense vapours on their summits, that life and agriculture are possible with the aid of irrigation.»

Upon this Prof. Mackinder rightly observes, that according to my observations the wind is the principal factor, and that it produces changes not only in the position of the rivers and lakes, at all events in the basin of the Tarim, but also compels the inhabitants to migrate, and, further, causes the deserts to expand and increase. I also am in full agreement with Dr H. R. Mill when he says:

»I think we may take it for granted, or take it as proved, that the amount of water-vapour in the atmosphere as a whole has remained the same during all historical time. So long as the existing ratio of lands and seas continues, I do not think there can be much room for any fluctuation in the actual amount of evaporation and condensation over the earth's surface as a whole, and any local desiccation



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would appear to be a case of unequal distribution. If the plateau regions of all the continents are undergoing desiccation, as seems probable, there must be an increase of precipitation in some other parts of the world.»

I have already stated that, according to my opinion, the Lop-nor-and-Kara-koschun has probably altered but little in size during the historical period, and that such oscillations as are proved to have taken place in its area have been purely accidental. Suppose we start from the assumption, that theoretically the terminal lake received in former times the same volume of water that it receives now, the lake must then have been greater than it is at present, because the numerous marginal lakes which we now find beside the lowermost Tarim did not at that time exist. But as we likewise know, from Chinese documentary evidence, that the lake was formerly small, it is clear that some other factor must *then* have lessened the volume of the water that entered it. What that factor was it is difficult to say, but with the help of the story we read in Abel Rémusat's *Historie de la Ville de Khotan* and such statements as this: »Khotan zählte damals [um 640 A. D.] zwar noch 100 Klöster, aber nur 5,000 Mönche, ein Viertel so viel als zwei hundert Jahre zuvor»,* we may infer that the population of at least this part of the country was in ancient times more numerous than it is now. There exist numerous indications that Chotan was a very prosperous and densely inhabited kingdom, and we may assume also that the other oases in the basin had at the same time — at all events larger populations than they have now. That population can only have existed by means of irrigation; it is this which lessened the area of the terminal lake, in the same way as the marginal lakes of the Tarim exercise a drain upon that river at the present time. The fact of the population being smaller now than it was formerly is not due, as Krapotkin asserts, to »the rapid desiccation of this region, which compelled its inhabitants to rush down to the Jungarian Gate, down to the low lands of the Balkhash and the Obi», but it is caused, not only by the migrations of the existing drift-sand, which encroaches upon the former cultivable ground, but also by the circumstance that the present inhabitants are an inferior and less enterprising race than that which formerly dwelt there. Climatic changes do not take place so rapidly in the heart of a continent as to give occasion to wholesale migrations of people, but on the contrary they proceed so slowly, that the human stock decreases parallel with the deterioration of the climate. But in East Turkestan there has not even been a deterioration of climate; for it is undoubtedly true, that if the possibilities of irrigation were exploited in a more rational manner, and even now with a more intelligent conception of the object to be attained, East Turkestan would be able to support a much more numerous population than it actually does. It is true, the towns which I discovered in the desert immediately west of the lower Kerija-darja, and which are now almost entirely smothered under the drift-sand, do seem to point to an enlargement of the area of the desert; and so too do the relics of antiquity which Stein discovered and thoroughly explored during his wonderful and remarkably successful journey. Moreover in several places it is easy to see how the caravan-road between Karghalik and Chotan is actually threatened by the advancing drift-sand — in fact, not very long ago the road was obliged to make a detour to the south in order to avoid an actual encroachment of the sand. At Ordan Padschah there are houses which stand in imminent peril of being buried under the invading sand. Yet all this should not mislead us into believing that within the narrow limits of historic time there has been any noteworthy augmentation in the volume of the desert sand. Its distribution is effected exclusively by the wind. An expansion or increase of the sand in one direction is counterbalanced by a corresponding diminution in another. I have assumed, that in the earliest centuries of our era the country south of the Lop-nor was covered with drift-sand, and that it also extended into districts where at the present day, owing to the hydrographical changes which have intervened, there exists no drift-sand whatever. Of course the drift-sand does increase from year to year, but the increase takes place so slowly that within the historic period it has not been noticeable. The desert however which lies west of the lowermost Tarim has, in consequence of the southward advance of that river, had its supplies of sand cut off. And as for the source whence the drift-sand comes, namely the mountains, and especially the Kuruk-tagh, I am convinced that these, even at the dawn of historic time, were exposed to the same energetic disintegration as now. Even though there were within the historical period — what I do not believe — a diminution in the water which has flowed down the rivers of East Turkestan, this would not to any appreciable extent have quickened the breaking down of the mountains. But on the other hand it is well known, that within that same period a number, if not indeed most, of the lakes of Central Asia have decreased in area. Whether and how far this phenomenon was connected with the last glaciation of the northern regions of the Old World I cannot determine, though I consider that any such connection is extremely improbable. The diminution in question points rather to the incidence of a climatic period, which, when it shall have reached its culmination in the present direction, will probably lead up to a slow augmentation in the volumes of the same lakes. But by any such climatic period the Lop-nor will remain unaffected; at all events it is impossible to prove that there has been any diminution in the water of the Tarim basin within historic times. Even in the lakes which Krapotkin names oscillations of less importance than the great period may be observed. He also mentions, that during the last twelve years the level of the Sea of Aral has risen four feet; a fact which seems to point to a heavier snowfall in the Pamirs during that period, or else, from some cause or other, to a lessened evaporation over the lake. For during these same twelve years there is nothing that seems to indicate any rise in the Kara-koschun, but rather the contrary, if my observations and Prschevalskij's be compared together.

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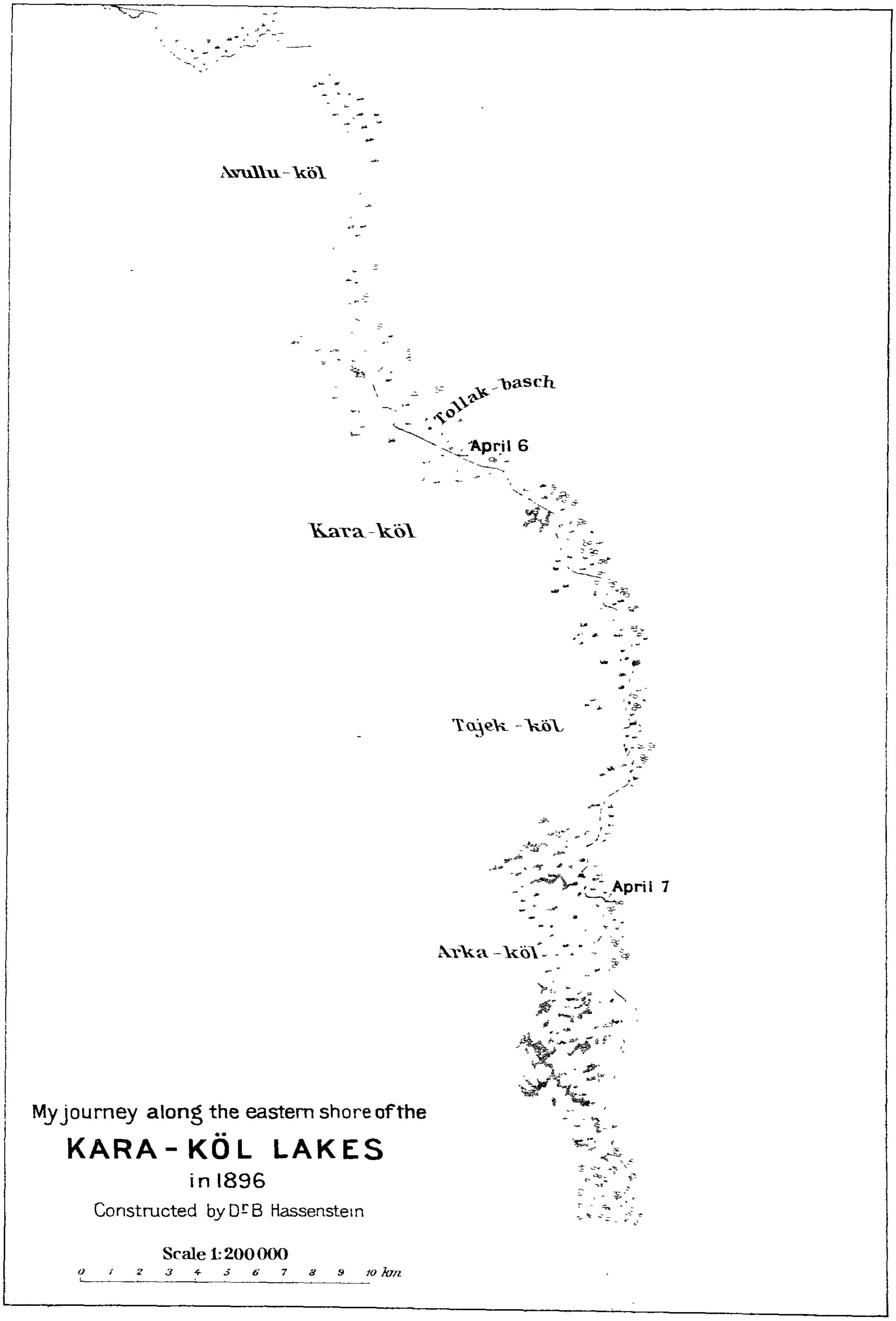
* Koeppen, *Die Religion des Buddha*, II. p. 35.

With the evident and constant diminution which is taking place in the Tibetan lakes at the present time, I shall have an opportunity to deal when I come to the fourth volume of this present work. Here I will only say, that Dr Blanford, when commenting upon Krapotkin's paper, expressed his doubts as to whether the whole of Tibet was once covered with ice, and this is in agreement with both Prof. James Geikie's view and my own observations.

In the beginning of his paper Krapotkin touches upon his conception of the Lop-nor problem, a matter with which I have already dealt in Chap XXI above.



My journey along the eastern shore of the

## KARA-KÖL LAKES

in 1896

Constructed by Dr B Hassenstein

Scale 1:200000

Gen. Stab Lit. Anst Stockh.

# CHAPTER XXV.

## COMPARISON BETWEEN THE TARIM AND OTHER CENTRAL ASIAN BASINS.

I have attempted to show that, although the terminal lake of the Tarim is, like most of the lakes of Central Asia, undergoing a process of desiccation, the process in its case, at all events at the present time, advances at a slower rate than in most other lakes; and the reason for this I trace to the vast extent of its source-regions, and to the fact that climatic changes which take place there could hardly make themselves noticeable in such a relatively short period as the historical epoch, or at any rate within a space of 1600 years. In this respect the Tarim, together with its terminal lake, occupies an exceptional place amongst the rivers of the earth; and I know no other instance that admits of full comparison with it, i. e. I know no other river that flows through a self-contained central basin, after gathering up its waters from a girdle of mountains that are beyond parallel gigantic, and then, in an excentrically situated part of its basin, forms an ambulatory lake on what is practically a dead level. There does indeed exist a certain degree of resemblance between the basin of the Tarim and the basin of Tsajdam; for the latter, although its area is only one-fourth of the area of the basin of the Tarim, likewise forms an elliptical depression, shut in by extensive ranges of mountains stretching from east to west. Yet in respect of height these mountains fall a long way short of those that encircle the basin of the Tarim, the reason being, at any rate in part, that the basin of Tsajdam lies nearly 2000 m. in absolute altitude above its neighbour. The result of the denudation processes which in the course of countless thousands of years have been going on in the border-ranges of the Tsajdam basin, and of all the gravel, sand, and sediment which have been transported by the rivers, streams, brooks, and torrents after the rains down towards the central parts of the basin, has been to fill it up to such an extent that the bordering ranges, as compared with the general surface, appear incomparably lower than the mountain-chains that shut in the basin of the Tarim. Taking the basin of Tsajdam as a whole, the surface slopes towards the east, just as it does in its larger neighbour; but taking the actual salt-marsh of Tsajdam proper, the fall is to the west or north-west, the direction in which the

Bajin-gol flows towards the Hollusun-nor. If this stream only carried a sufficient volume of water, it would probably continue in the same direction as far as the neighbourhood of the Tadschinur-nor, and the Naidschin-gol and Tschulak-akkan (with the Utu-muren) would then become southern affluents, similar to the Chotan-darja and the Kerija-darja. Something similar to this has no doubt existed at some period in the past, and probably the river system of Tsajdam possessed at that time, even as the Tarim system does now, a terminal lake, which possibly was just as restless and inconstant as the Lop-nor. On the other hand in the unique hydrographical system of the former we have, in the splitting up of the main stream into a number of smaller streams mutually independent of one another, evidence of a more advanced stage of development, and may therefore assume that this condition is typical of what will happen in the Tarim system at some epoch still very distant. The fate of the Naidschin-gol has already overtaken the Kerija-darja, though the latter, contrary to the former, has created no terminal lake, the reason being the distinct fall which the surface of East Turkestan has towards the north, so that the stream continues to flow on until it dies away in the sand.

The interior of the basin of Tsajdam is however far less known than the interior of East Turkestan; for whereas we are able to draw hypsometrical curves for the latter, we do not possess sufficient observed data to enable us to do this for the former, even approximately. And even in the case of East Turkestan there are restricted areas in which we fumble with a good deal of uncertainty, as, for instance, the desert of the eastern Takla-makan. Where it not that we have reason to suppose, that the Kerija-darja follows a chain of bajir-depressions running north-north-east, and that the Tschertschen-darja coincides with a wind-eroded hollow, we should be tempted to look for a natural swelling of the surface, however slight, between these two streams.

One difference between the basin of the Tarim and every other basin I have visited in the interior of Asia is that in the latter the absolutely deepest part generally admits of being easily pointed out, whereas in the former that is not the case. If we take, for instance, the trough-like valley of the Baghrasch-köl or any self-contained basin you please in Tibet, we should be able from the edge of the saucer-shaped depression to draw radical gradient lines which would cut the hypsometrical curves at right angles, and would all meet in one point, namely the absolutely lowest point. In the Tarim basin the absolutely lowest point we ascertained to be the 14.0 m. sounding I obtained at Markat, but at the same time we have also ascertained that this value is entirely ephemeral, being dependent partly upon the filling up of the basin with sand and sediment, partly upon wind-erosion in some other region. It is a necessary implicate of the very nature of the case, that, if the terminal lake is ambulatory, the absolutely deepest point must be ambulatory also, and the conception of gradient lines in the Desert of Lop is so uncertain and so transient that it would be a waste of labour even to attempt to draw them.

Of lakes that are disappearing, or have already disappeared, there exists no lack in Central Asia. On the other hand desiccated depressions are extraordinarily common, especially in Tibet, where, later on in this present work, we shall have an opportunity to become acquainted with several of them. Obrutscheff visited two of these ancient lakes between An-si and Su-tscheo, which are consequently situated due east of Lop-nor and between precisely the same mountain ranges as that lake, and he has explained the causes of their disappearance, i. e. as lakes. His conclusions too have met with opposition, and he has been drawn into controversy in defense of them, though he has had no difficulty in maintaining his ground. The lake problem in question presents so many points of resemblance to the Lop-nor problem, and yet at the same time so many instructive differences, that I cannot abstain from quoting his conclusions *in extenso*, more especially as his observations, which are of exceptional importance and value, are for the most part not very easily accessible, because his great work on the Nan-schan is only published in Russian.*

With great scientific sagacity Obrutscheff from the exposed sloping shores of the Mogutun-gol draws the inference, that the depression at the foot of the Nan-schan, north of the town of Jü-min-sian, must in former times have been occupied by an extensive lake. Then he goes on to say:** »The character of the locality and the nature of the ground both suggest that the lake occupied the whole of the present salt steppe around the oasis of Schi-dun-tse, from the Mogutun-gol to the bare hills in the east. Its northern boundary was formed by the hills of Schi-dun-tse and the gravelly desert at the southern foot of the Bei-schan. The lake extended of course south and east beyond the Mogutun-gol; but as I did not visit those localities I am unable to define exactly its western and south-western boundaries. Judging from M. E. Grum-Grschimajlo's map, the lake would appear to have extended 25 versts westwards from my camp at Mogutun-gol. On the south it was bordered by low hills and plateau-like elevations, stretching south of the steppe of Schi-dun-tse. On the whole the lake would seem to have measured approximately 80 versts in length and from 3 to 20 versts in breadth.«

»East of this lake, in the neighbourhood of the existing oasis of Chor-chi-tse, there was another lake, possibly connected with the former by river-arms, for this locality lies 70 to 100 meters lower than the steppe of Schi-dun-tse. The second lake was rather shorter than the first, its length amounting approximately to between 50 and 60 versts, and its breadth to 25 versts; but it was deep. On the west it extended probably to the bare hills recently mentioned, and may have been connected with the former lake by means of small sounds winding between the hills.»

»On several contemporary maps we still see depicted, and clearly in dependance upon Chinese maps, the two lakes Chua-chai-tsi and Alak-tschi, the former on the steppe of Schi-dun-tse, the latter in the oasis of Chor-chi-tse. Now however we find, instead of the former lake, an extensive salt steppe, with the remains of a salt marsh and with sandy hills, and instead of the latter sandy hills and dunes, as well as the remains of a salt-marsh and saliferous steppe.«

»Hence, in the light of the observations just cited, it seemed to me that in my preliminary report I was not only warranted, but was even obliged, to correct the errors into which G. E. Grum-Grschimajlo falls with regard to this region, when he says, The considerable lakes (Alak-tschi, Chua-chai-tsi, and Tschin-schen-ho) which are shown on our maps do not exist, indeed never can have existed, because the topographical relations of the region forbid it. To this I replied, I seize the opportunity to observe, that the lakes Chua-chai-tsi and Alak-tschi, shown on our maps, really do not exist now, as G. E. Grum-Grschimajlo has pointed out; but there it nothing in the topographical relations of the locality to prevent their existence, as that traveller supposes, and without doubt the lakes did once exist, and existed probably in the historical period (otherwise they would never have been shown on the Chinese maps), and, equally without doubt, they have left behind them marshes, salt expanses, and beds of kamisch, which in certain places come to light in consequence of the paludal character of the region, though not at all seasons of the year. In the desiccation of these lakes an important part was undoubtedly played by the rivers and brooks which formerly fed them and were subsequently employed for irrigation, thus acting as a drain upon them, and this did happen of course within the historical period.»

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* *Tsentralnaja Asija, Severnij Kitaj i Nan-schan 1892—94*, by V. A. Obrutscheff.

** Vol. I. pp. 605 ff.

Notwithstanding this unambiguous correction by Obrutscheff, Grum-Grschimajlo proceeded, in the second volume of his voluminous book of travel, to speak of these lakes in the following terms, according to Obrutscheff's quotation of his words: »The biggest of these troughs (depressions), the western one, contains the lower part of the river Su-lai and the basin of the lake Chara-nor. On the east it leans upon the ridge San-sjan-tsi, which, after crossing over the valley of the river Su-lai-che, is almost connected with the Bei-schan mountains; these last reach all the way to the vicinity of the stream just mentioned, and then bend towards the north, and advance very nearly all the way to the meridian of the fortress of Tschi-dao-gou. Nevertheless the bend is but slight, and only a few versts farther on the Bei-schan again approach the Su-lai, leaving between themselves and it a not very broad (3 to 8 versts) strip of firm ground, which, except in moist places, where it is overgrown with kamisch, is entirely barren, unless we count the rare bushes of *Eurotia ceratoides* and *tschi*. The occurrence of these features led me to observe, that the lakes Tschin-schen-che and Chua-chai-tsi, which are depicted on our maps, not only do not exist now, but never can have existed in the situations shown. And in the same way the lake Alak-tschi, as we shall see lower down, can hardly have existed to the east of the last-named, at all events within historic times.»

»Obrutscheff however is unable to accept these conclusions, for he writes, that the lakes in question, 'after having left behind them marshes, salt expanses, and beds of kamisch, which in certain places come to light in consequence of the paludal character of the region, though not at all seasons of the year', must undoubtedly have existed during the historical period, because 'otherwise they would never have been shown upon the Chinese maps'».

»Now, seeing that Obrutscheff travelled to Bei-schan by the same route that I followed, I understand distinctly what it was he took for traces of the 'historical' lake of Chua-chai-tsi. It was the region bordering upon the river Bulungir, which in the Mongol period was artificially irrigated. Into the channel then excavated the water penetrates pretty often even now, and proceeds north as far as the well of Si-dun, where it forms what the natives of the lower part of the river Ob call *sor*. But may we, properly speaking, apply the term lake to such artificial sheets of water?

With regard to Obrutscheff's appeal to the Chinese maps, I would beg leave to make the following observations —«

»On D'Anville's map, published in 1737, we do not see any traces whatever of the lakes Tschin-schen-che and Chua-chai-tsi; nor are they shown on the later maps — either on Grimm's of 1833 (which is a copy of Klaproth's), or Jakinf's. They first make their appearance on the Chinese map Dao-tsin-i-tun-jü-tu, published in the year 1864, and from it were transferred, first to Richthofen's maps, and then to others published in Europe, none of the cartographers in question being deterred from inserting these lakes by the obvious impossibility of carrying a caravan route diagonally across a vast sheet of water. From this it results that the fabrication of the lakes in question must be assigned to quite recent times.»

»With regard to the lake of Alak-tschi the matter is otherwise. On D'Anville's map this lake (Alak-nor) is represented as being entered by two nameless river-arms (the Tschi-jo-che and the Ma-ge-tschen). On Grimm's map there are two small lakes, the Altan-nor and the Alak-nor. Finally on Jakinf's maps we have two unnamed lakes, a western one at the mouth of one of the branches of the Bulungir, the eastern at the mouth of the river Ma-ge-tschen, which rises in the springs and marsh of Tschi-tsin-chu. This lake really does exist; its immediate vicinity is thickly beset with kamisch thickets, which are at the present time the property of the Mongols, the descendants probably of the Tschigintsis.»

»From the preceding discussion we may deduce the following conclusion, that during the Jüan period, when the Mongols who were settled in the Jü-min region wanted winter grazing for their animals, they cultivated meadows there by leading the water of the Bulungir down by artificial canals to the districts which lay not higher than the level of the river at the high-water period. It is these temporary sheets of water (*sor*) which have found their way into the Chinese maps under the disguise of permanent lakes; while on Jakinf's maps they figure as large but unnamed sheets of water into which one of the branches of the Bulungir empties. Perhaps this is the Chua-chai-tsi, which we have again in the Chinese atlas of Dao-tsin-i-tun-jü-tu.* A long way to the east of this region of periodical inundation we find the actual lake, formed by the inflow of the river Ma-ge-tschen. Although considerably reduced in area, it still exists at the present time; on Kreitner's map it is called Pa-lin-chai. Apart from these, there are no other lakes on the north side of the great highway from Jü-min to Su-tscheo, nor to I think that any can exist there at all.»

»East of An-si, the Dun-chuan cauldron valley (*Mulde*), there exists what might be called the Jü-min valley. North and north-west it is bounded by the mountains of San-sjan-tsi and their prolongation, the ridge of Daban-sjan; on the south and south-east by the offshoots of the Nan-schan Mountains and the Tschi-tsin-schan Mountains. East of these last there is a third *Mulde*, which has an almost meridional situation and on the north leans against the Bei-schan. As its north-western boundary we may take the flat, scarcely perceptible slope which without doubt forms a continuation of the western wing of the Tschi-tsin-schan Mountains».

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* To this Obrutscheff adds the following correction: »If this is the case, then the lake of Chua-chai-tsi existed on Jakinf's map *before* the publication of the Chinese atlas (1864), so that the 'fabrication' of this lake must be ascribed to Jakinf, whose work was printed in 1851, or 13 years before the publication of the Chinese atlas. For this reason Mr Grum-Grschimajlo omits to give the dates of Jakinf's maps.»

Lower down Obrutscheff continues —

»Upon these passages, cited from Mr Grum-Grschimajlo's account of his travels, I have to remark as follows: Nothing is said about the topographical relations of the region rendering the presence of these lakes impossible, and this was the point at which my objection was especially levelled, more particularly as the phrase involves an inaccurate characteristic of the region. The explanation of the origin of this phrase, which occurs in the opening sentence of the quotation, is in every way unsatisfactory; for, in the first place, the account of the topography of the region is too brief and too confused — it would have been useful to have had a sketch-map based upon Mr Grum-Grschimajlo's own observations, because the large map that accompanies his book does not accurately represent the real orographical relations — in the second place, towards the end the quotation gives an account of the cauldron-valleys, and amongst them of the Jü-min valley and the next following depression of In-pan-fu-tsi (my oasis Chor-chi-tse) to the east of it, that is to say the precise spot in which I place the lakes under discussion. Now trough-shaped depressions represent, as is well known, precisely this form of relief, and not only are they not antagonistic, but they are actually favourable, to the formation of lakes.«

»Further Mr Grum-Grschimajlo says, with regard to the lake of Chua-chai-tsi, that, according to tradition, it owes its origin to the artificial irrigation of the tracts adjacent to the river Bulungir in the Mongol period. Let us assume that this really was the case, although the author does not tell us by whom the tradition was preserved, nor, if it is due to himself, does he tell us where he picked it up or when. But, after all, is it not really a matter of indifference how the lake was formed, whether artificially or naturally? Anyway it did exist, that is to say its origination was in no way prevented by the topographical conditions. But these conditions, taken in conjunction with the character of the soil in the depression, with the traces of ancient shore-lines at the foot of the Bei-schan, and with the conformation of the surface in the shore-terraces of the Mogutun-gol, prove that the lake of Chua-chai-tsi did exist long before the Mongol period, or indeed even before the historical epoch. I have already indicated its boundaries, based upon topographical facts and upon the properties of the surface. It was fed by a branch from the river Bulungir (Su-lai-che), and its surplus water flowed westwards, possibly to the other lake situated in the An-si and Dun-chuan depression, and did so by a channel which cut its way through the ridge called by Mr Grum-Grschimajlo the San-sjan-tsi. This ridge was indeed one of the first conditions for the creation of the lake, owing to its acting as a natural dam shutting in the western end of the Jü-min depression. The cause of the disappearance of the Chua-chai-tsi is perfectly intelligible. In proportion as its drainage channel gradually cut its way deeper and deeper through the ridge of San-sjan-tsi, the surface of the lake was naturally lowered, and so gradually became shallow, and divided into pools, surrounded by salt marshes and kamisch-thickets, but connected together by channels, precisely as in the existing lake of Lop-nor. It is to this period that we must assign the upper part of the deposits on the terraces of the Mogutun-gol. At a later date these small lakes disappeared, and the Bulungir began to cut its way through the former lacustrine deposits; though when it was in high flood, the river was at the same time able to overflow the salt expanses and meadow-lands nearest to its banks. This is the epoch to which Mr Grum-Grschimajlo refers, when he speaks of the artificial irrigation of the meadows by the Mongols during the Jüan period, that is about the year 1368 A. D. At the present time it would only be possible to irrigate in this way the eastern part of the depression, around the well of Si-dun; in its western part the stream has cut too deeply into the former bed of the lake to permit of the water flowing over.»

»With regard to the lake of Alak-tschi, Mr Grum-Grschimajlo says in the beginning of the passage quoted, 'In the same way the lake Alak-tschi, as we shall see lower down, can hardly have existed, at all events within historic times'; and on the next page he adds, that this lake is shown on the maps of D'Anville, Grimm, and Jakinf, and that it actually does exist.»

»It will therefore be clear which of us is right, and I ask Mr Grum-Grschimajlo, what profit it will serve to continue the controversy? Would it not be better to adduce historical and cartographical corrections, in support of the former existence of these lakes, and drop the hasty phrase made use of in his book, that these lakes could not exist. But in the beginning of the passage I have again quoted from him he once more repeats the same phrase, although in a less aggressive form; then he reproduces my first refutation incorrectly; and finally takes pains to prove that it is unfounded. In doing that he is however most unfortunate in his choice of method; for it is evident from his own words, that one of these lakes was formed within historical times by artificial means, and that the other exists even at the present day, and there really is nothing in the topographical conditions to prevent either the one or the other lake from coming into existence.»

For so well-trained a geologist and geographer as Obrutscheff it was not difficult to interpret the relief features of the country, and to trace out their connection with the hydrographical relations that obtain in that region; and his rigidly critical statement of the problem is a guarantee that he has not made a mistake. The similarity between this problem and the Lop-nor problem, to which I alluded in the beginning of this chapter, lies in the fact that both lacustrine groups belong to the same gigantic latitudinal valley, and that the solution offered in both cases alike has given rise to a lively controversy. Grum-Grschimajlo has employed all his acumen and learning in defence of the opinion to which he has given utterance; Kosloff has done his very best to maintain Prschevalskij's right to be the discoverer of the Lop-nor. But in both cases alike these laudable efforts have had to yield before exact investigations into the actual facts, and scientific truth, to which all other considerations must yield, has gained the victory.

But from the physico-geographical point of view there exists great dissimilarity between the two lakes. The Lop-nor is an ambulatory lake, a terminal basin: the Chua-chai-tsi occupied a permanent situation, and was not a terminal lake, but one which the river that entered it at one end quitted again at the other, and it disappeared in consequence of the erosive action of its drainage stream. The Lop-nor had at the dawn of historical time pretty much the same dimensions as the Kara-koschun has now. The Chua-chai-tsi existed prior to the beginning of the historical epoch, and by the year 1368 had for the most part disappeared. In this circumstance we have a direct point of comparison for estimating the length of the period during which both lakes were drying up. In the case of the Lop-nor we have ascertained that this period must have been very long, because the climatic changes in the vast area drained by the river would necessarily demand an immense amount of time. In the case of the Chua-chai-tsi the period must have been considerably shorter, because the process of erosion advances at a very much more rapid rate. The former lake shifts its position periodically whenever its bed gets filled up; whereas the basin of the latter becomes only in part filled with solid material, and would continue to occupy its bed for some considerable time, were it not that there is a gap in the side of its trough-shaped depression.

# THE CENTRAL ASIAN DESERTS, SAND-DUNES, AND SANDS

# CHAPTER XXVI.

## THE DESERTS OF ORDOS, KUM-TAGH, KASCHGARIA, AND AK-BEL-KUM.

In the preceding chapters I have frequently had occasion to dwell upon the extension of the drift-sand and the sandy deserts in that part of Central Asia upon which our attention has been hitherto fixed, and I have endeavoured to convey some idea of the eternal warfare that is waged between the sand and the running water. It would, I am sure, be very interesting to compare and contrast critically the observations I have made with those recorded by other travellers in other drift-sand regions in the interior of the continent; but on the other hand such an investigation hardly falls within the scope of the task I have set myself in the present work, a task that is in itself sufficiently exacting without my deviating into side-paths, however tempting. The proper place for a comparative monograph of that character would be a handbook on the physical geography of Asia. As for my own observations, I must content myself with referring to the descriptions I have already given in the course of the present work, and to the account which follows of my journey across the Desert of Gobi between the Kara-koschun and Sa-tscheo, as well as to my previous treatise in *Petermanns Mitteilungen*, Ergänzhft. No. 131, pp. 218—268.

However, with the view of showing that the part of the Desert of Takla-makan which I have called the Desert of Tschertschen is in respect of structure and relief quite unique, at any rate amongst the sandy deserts of Central Asia, I will here interpolate certain observations which other travellers, especially Russian travellers, have made about that part of the world. I have no intention of offering a complete survey of all that these travellers have written about the sandy deserts through which they have travelled. All I shall do will be to make a hurried selection from amongst the material at my disposal, and I will then close this section of the work with a brief comparison between the Takla-makan and other sandy deserts in those parts of Asia which will admit of comparison with it. And I may all the more readily do this because Potanin, in the account of his 1884—86 journey, has given a valuable and instructive survey of the distribution of the deserts of Asia. Accordingly I venture to begin with a quotation from his book. —

»The direction in which the sandy masses of Ordos are moving may also be observed outside its own boundaries. For instance, we were told by the Catholic missionaries, that the town of Ning-tschao-ljang, south-east of Boro-balgasun, was overwhelmed by sand that came from the west. South of Ordos we saw how the sand in the vicinity of the village of Tao-tung-tsa was heaping itself up on the right side of a ravine, that is to say on that side which looks towards the Yellow River. Near the town of Chua-ma-tschen the Great Wall is covered with sand that came from the west. With regard to the town of Suan-chua-fu, Armand David writes, that the local prevailing winds bring with them immense masses of sand, which have so completely covered the western town-wall that men, as well as wolves and foxes, are readily able to find their way over it into the town. Mr Garnak, who lately completed a journey from Peking to Manchuria, says only, that in the south-eastern corner of Mongolia, i. e. east of the Southern Chingan, he encountered masses of sand travelling from west to east. Prschevalskij does not give any information of this character at all, either about the sand that lies along the northern elbow of the Yellow River or about the sand of Tengeri. Kreitner encountered barkhans west of Su-tscheo, especially around the town of Dun-chuan; but in his book, *Im fernen Osten*, we have not a single statement as to the direction in which the sands move. He reports that the northern slopes of the range of Tapan-san are covered with sand, whence we may conclude that it has been blown there by northerly, or at all events by north-westerly, winds. The circumstances we observed in this part of Mongolia, in the districts west of the town of Gao-taj, likewise point to the incidence of north-westerly winds. Although we had no opportunity to cross the region proper of the barkhans in north-west Mongolia, we had the good fortune to see, in the valley of the Gaschiun-tsuche, how sharply the advance of the sand is defined, for it is there heaped up along the whole of the western side of the *thalweg*, and it has come from the west.»

After that Potanin goes on to give a readable account of the formation and structure of the Mongolian dunes, and the occasion of their origination, and then continues:

»Contrary to what Prschevalskij has observed in one passage (I. p. 134) of his *Mongolija*, it is the effect of the winds, and not the effect of the rain, that checks and moderates the barkhan waves. The influence of the rain is indeed so feeble that, even after a heavy downpour, as we observed, the slight ripplings on the surface of the barkhans were in no way altered or disturbed.»

»From what quarter is it that the wind originally derives the materials out of which it builds up the barkhans? Unless they are to be considered as a continuation of the sandy desert of Tengeri, then their derivation must be traced to the red sandstone mountains of the provinces of Schen-si and Gan-su (Kan-su). The sandy masses in the alluvial valley of the Yellow River, above Lan-tschou, are of a grey colour, not yellow, and if they contribute in any way to the formation of the barkhans of Ordos, it is as a by-product amongst other varieties of sand. The source of origin of the sandy masses in Kusuptschi, and in general of the barkhans which accompany the northern bend of the Hwang-ho, as also of the barkhans of Tengeri, is probably to be found on the northern slopes of the Nan-schan, that is if we consider that the predominant winds of the country blow from the south-west. The first disassociation of this material from the ancient deposits must be ascribed to the small streams, and even the rain-torrents. North of the sandy desert of Tengeri stretches the Gobi, occupying the bottom of an ancient lake or sea. Its surface consists of intermingled sand, dust, and pebbles, and this semi-powdery alluvial material rests upon assorted gravel. Here then the wind, unaided by water, is able to pick up directly from the sediment the materials it requires for building up the barkhans, and it does carry away sand and dust, though it leaves the gravel behind, to form the upper layer of the deposits there. The sandy masses which are thus transported from this region must be sought for somewhere north of In-schan.»

»The same circulation that takes place in the case of the matter held in suspension in water takes place also in the case of the matter that is transported by the atmospheric currents: while the heavier particles soon drop, the lighter are carried on farther. The pebbles and gravel remain where they are; the sand however is transported farther by the current of the atmosphere and used by it in the formation of barkhans; while the more volatile dust, which is derived in part from the deposits, and is in part produced by the friction of the sand of the barkhans under the action of the winds, is carried yet farther still. This current of atmospherically borne dust must be a good deal broader than the atmospheric current that transports the sand. The finer the dust the longer it remains buoyant in the atmosphere; and it only drops to the earth when the atmosphere has been for a long time quiescent or when it is carried down by the rain.»

»If our observations with regard to the presence of prevailing south-west winds in Ordos are confirmed by other travellers, and if they are found to hold good at other seasons as well, it will be easy to understand, that parallel with them there exist currents of sand and dust which likewise travel in the same direction. Hence it is probable that this flow of dust starts at the foot of the Nan-schan, and proceeds along the Chingan Mountains to Kerulen . . .»

»There is a certain amount of regularity observable in the distribution of the sandy deserts over the vast uplands of Central Asia. It would be instructive to have a map of those parts of Central Asia that especially lend themselves to the distribution of the sand. The first glance at such a map would at once show us, that two agencies are represented in this distribution, though what they really are is not quite clear; and of these two agencies one prevails in the north-west, the other in the south-east, so that the whole of Central Asia may be divided into two regions, the dividing-line between them being drawn from north-east to south-west, from Urga *via* the eastern end of the Tjan-schan (Tien-schan) to the city of Kaschgar. North-west of this line the sandy masses are broken up into detached and disconnected areas, and are almost without exception heaped up around the lakes, and consequently in the lowest parts of the several districts in which they exist. Moreover we find also that these sandy tracts always occur on the western or south-western shores of the lakes; this is the case with the lakes of Balkasch, Ala-kul, Ebi-nor, Ajar-nor, Orku-nor, Sajsan, Ulungur, Ubsa-nor, Durga-nor, and Chara-nor, lying east of Kirgis-nor.»

»South-east of the line we have indicated the arrangement of the sand is quite different. In that part of Asia we have three gigantic, but disconnected, basins.

The first, lying farthest east, is embraced on the one side by the ramifications of the Gentej and Changaj and on the other by the In-schan. The second, or middle, division is contained between the Altai of the Gobi and the Nan-schan. The third basin, in the west, lies between the Tjan-schan (Tien-schan) and the border-ranges of Western Tibet. The eastern basin is separated from the middle basin by a mountainous tract, forming a continuation of the Altai of the Gobi and uniting the Tjan-schan with the Nan-schan. The deepest parts of each of these three depressions occur near their northern borders; towards their southern boundaries they are all alike very much higher . . . Here however the sandy deserts are not found in the low-lying tracts, but occur on the higher uplands that foot the southern mountain-ranges, the In-schan and the Nan-schan. Our maps show an immense expanse of sand south of the Tarim in the western basin; beginning in the neighbourhood of the city of Jarkent, it extends eastwards past the towns of Chotan, Kerija, and Tschertschen to Sa-tscheo. Along this stretch there is only one locality that forms an exception to the rule we have indicated, namely the region round the lake of Lop-nor. In the middle basin the widest expanse of sand occurs between the Edsin-gol and the range of the Ala-schan. On the south it extends nearly as far as a line drawn through the towns of Ljan-tschou, Gan-tscheo, and Gao-taj at the foot of the Nan-schan; but on the north it does not approach anything like so far as the latitude of the lake of Gaschiun-nor. Still farther east come the sandy deserts of Ordos, extending south-eastwards as far as the mountain-range that separates Ordos from the provinces of Schan-si and Schen-si. In the eastern basin drift-sand is encountered between the district of Ude in the north and the foot of the In-schan in the south.»*

From Obrutscheff's account of the sand-dunes in the desert-regions that he visited we gather the impression, that they are in no way comparable, in respect of either size or distribution, with the sand-dunes of the Takla-makan. His accurate and detailed descriptions suggest that, with the exception of the Kum-tagh, they as a rule barely exceed a medium altitude. Speaking of the belt of dunes between Siao-tschao and Ning-tschao-ljang in southern Ordos on 13th February 1893, he says:

The sand occurs at first in the shape of hills: then the road crosses over a belt of sand-dunes (barkhans) 2 to 2½ versts broad. The individual dunes ascend to an altitude of 2½ sashen, and are clearly somewhat mobile, quickly changing their position under the influence of one wind or the other. A strong south wind, which blew all day from early in the morning, shifted at about 3 o'clock to the south-west, and not only altered the finer lines on the superficies of the dunes, but actually re-shaped their crests, by endeavouring to dispose them from north-west to south-east» . . .**

Writing on 12th December 1893 about pretty nearly the same region, he says: »From this depression the road gradually penetrates a series of sandy hills, which, according to the information I received, stretch from west to east for a distance of 200 versts, that is from the Yellow River far into the interior of Ordos, and on the south approach close to the Great Wall, thus giving them a breadth of more than 100 versts. For the most part the sand is built up into hills, some of them half covered with vegetation, others entirely covered; but in certain localities there occur patches of more or less bare sand-dunes (barkhans), generally irregular in outline, this being a consequence of the unevenness of the surface. As a rule they turn their steep faces towards the east and east-south-east, and reach altitudes of 3 to 4 sashen, seldom 6 or 7. The sand of both the barkhans and the hills is greyish yellow, and fine-grained, though in the hollows between the dunes it is somewhat coarser. The hills that are in part overgrown with vegetation show plainly the outlines of the barkhans, with their steep slopes looking towards the east or east-south-east. In those that are entirely clothed with vegetation the slopes generally exhibit everywhere the same degree of steepness, and the hills are arranged in no sort of regular order. In certain places there are ridges 1 to 2, seldom 4 to 5, sashen high, entirely or one-half covered with vegetation, and extending from north to south, or from north-west to south-east, with their steep slopes turned towards the east and north-east, while those that are in part bound together by vegetation are covered with a layer of fresh sand.» Then he goes on to speak of terraces 1 to 2 arshin high, of depressions, large basins $^1/_2$ to 1 verst in diameter, and of pits 1 to 2 arshin deep, into which the water apparently gathers after rain. »The depressions are as a rule drawn out from east to west, but are irregular in outline, penetrating like bays amongst the dunes. Their bottoms are strewn with sand or consist of sandy clay, and show in places patches of crystallized salt.»

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* G. N. Potanin, *Tangutsko-Tibetskaja Okraina Kitaja i Tsentralnaja Mongolija, 1884—86*, vol. I. pp. 96 ff.

** V. A. Obrutscheff, *Tsentralnaja Asija, Severnij Kitaj i Nan-schan 1892—94*, vol. I. p. 217.

Obrutscheff, continuing his journey through the same sandy desert, writes (Dec. 13): »The sand-hills that are in part overgrown with vegetation often have a cauldron-shaped indentation in the gentle slope that looks towards the north-west, rounded by the wind into a semi-oval or semi-circular shape, so that that face of the dunes generally assumes the form of a horse-shoe-shaped wall, the outer slope of which is still steeper, while the inner slope has a more gentle descent. The steep south-eastern flank of the dunes is frequently buttressed as it were by low ramparts of sand, formed of material blown out of the cauldron-shaped indentations just described. In some places the steep sides of these sandy ramparts have a fall of 40°, the sand being bound together and kept in position by grass and bushes.»*

From these descriptions it is evident that the sand in southern Ordos is low, not exceeding 15 m. in height, irregularly arranged, capricious, dependent upon winds blowing from various quarters, different winds being predominant at different seasons so that the position of the dunes relatively to the points of the compass varies several times in the course of the year. This however, as we have seen, is never the case in the Desert of Tschertschen. Obrutscheff speaks of as many as three different stages or »storeys» of drift-sand, each possessing different characteristics. The small depressions are probably equivalent to the bajirs; the larger sand-free spaces remind us of similar features in the Takla-makan proper, between the Jarkent-darja and the Chotan-darja. The terraces are probably similar formations to the jardangs.

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* *Op. cit.*, p. 259.

The same author gives the following description of the region between the Chara-narin-ula and the Yellow River: »Six or seven versts from the foot of the range (Chara-narin-ula) the road crosses a depression like a river-bed, about 100 sashen broad, and with bare clay at the bottom, but in general the course is not very distinctly indicated. Possibly this is an old bed of the Hwang-ho. In its bottom there is a well 1½ arshin deep, and on its southern bank the sand-hills have much steeper slopes towards the south-east. Farther on the cauldron-shaped depressions amongst the sand-hills grow more numerous; the surface within them consists of yellowish grey or brownish yellow clay, with frequent crystallisations of salt. At intervals on the hills, but especially in the cauldron-shaped depressions, there are small beds or low reeds. In the latter there exist also accumulations of sand, 3 to 4 arshins high, and overgrown with charmik. Gradually the sand-hills grow higher, reaching up to 5 or 6 sashen, sometimes to 8 or 10, and in shape they approximate more and more to the type of the barkhan, having their steep slopes turned towards the south-east, and their crests running NE. 35—40°. It is quite evident that the effect which the prevailing west-north-west and north-west winds exercise upon the accumulation of the sand increases directly as the distance from the foot of the mountains, for these serve as a gigantic screen. The sand in the barkhans is fine-grained, but in the depressions somewhat coarser; here however we no longer have such broad crests or such coarse sand as to the north of the old river-bed. On the other hand saksaul appears here in the form of bushes and trees about 4 arshin high. At 10 versts from the mountains the surface begins to rise, while the sand-hills grow fewer, and at the same time their altitude diminishes. In between the hills, barkhans, and chains of dunes there are level tracts, more or less extensive in area, with clay soil, in some places bare, and slightly grooved, but for the most part bearing bushes. Often the clay is covered with a layer of sand, and on it grow grass and bushes of various kinds. In these tracts there are small sand-hills recently heaped up, 2 to 4 arshin in height . . .»

»Upon a reconsideration of the higher and barer belt of sand, accumulated in the depression, 4 to 5 versts broad, that lies along the foot of the range of Chara-narin-ula, and corresponds to the ancient bed of the Hwang-ho, it became even more unmistakably clear that it must have been a long time ago when this channel was abandoned and fell a prey to the sand. This sand, to judge from the direction of the barkhans and the crests of the barkhan-chains, must have come from the north-west, for the steep sides are turned towards the south-east; and this too was the story told by the particles of sand, for they grew smaller and smaller the farther we proceeded towards the south-east. The heaping up of the drift-sand in the ravines and gorges of the Chara-narin-ula proves that a part of the sand is carried thither by the wind from Central Mongolia, over the top of the range. Another portion is formed *in situ* out of the old alluvia of the Yellow River and the disintegrated material of the screes deposited by the erosion torrents of the mountain-range.» *

Finally Obrutscheff gives the following description of the sandy desert of Kumtagh (Scha-schan), lying east of Turfan and south of Pitschan, the date being the 3rd

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* *Op. cit.*, vol. II. p. 473.

September 1894: »At three o'clock in the afternoon, when the power of the sun was already declining, I set off on foot to visit the Kum-tagh. Seen from a distance, the masses of sand have the appearance of a perfectly naked range, tolerably high and divided into several parts. The crest is somewhat denticulated, and in some places the passes are rather deeply notched. The range has numerous ramifications, and on their slopes are ridges and barkhans of secondary rank. The sand-hills are connected with the circumjacent heights by broad saddles, likewise covered with barkhans. According to the natives the belt of sand is about 40 versts broad from north to south, and its length from east to west about 60 versts. South of the Kum-tagh stretches the Desert of Gobi. The country between my camp and the foot of the Kum-tagh was for a distance of more than one verst clothed with vegetation, reeds and bushes more or less dense, but there were no trees. The soil consisted of dark grey clayey sand, resting upon clay, with saline incrustations and crystallised salt. Amongst the vegetation near the foot of the sand were small scattered patches of meadow, with fine grass and reeds, as well as fields in which water-melons and melons are cultivated. Water is no doubt found there very near the surface, for we observed neither ariks nor wells for irrigation.»

»Along the northern foot of the Kum-tagh stretches a belt of sand-hills, 100 to 150 sashen wide and 2 to 3 sashen high, and covered with scrubby bushes; as compared with the gigantic masses of sand, these sand-hills looked like mere insignificant swellings of the surface. To the north, that is in the direction of the oasis, the huge masses of sand are interrupted by a broken ridge of eminences overgrown with tamarisks, and on their northern slopes with reeds as well. The ridge in question does not run in a straight line, but in zigzag loops like the foot of the Kum-tagh. Between these sandy eminences and the Kum-tagh there is, further, a chain of small depressions, overgrown with reeds and bushes. The absolute altitude of the belt of sand at the foot of the Kum-tagh is 500 m.»

»So far as I visited it, the Kum-tagh was built up of compound barkhans or barkhan mountains, disposed in broken lengths, with their long axes stretching N.W. 290° — a consequence of the predominance of the north-north-east wind — and connected together by means of saddles. These, in the cases in which two neighbouring mountains lie close together, assume the form of sharp, deeply sunk crests, with both slopes showing the same degree of steepness, 30° to 35°, and sometimes as much as 40°. The flanks of the mountains are thickly beset with heaped up barkhans and barkhan ridges, resembling sharply accentuated ramifications, which extend principally NW. 310°—315°, often also N. and S., and even NE. 5°—10°, more seldom NE. 80°. These directions indicate that the prevailing winds blow from the north-east, the east, and, to a less extent, the north. The crests of the barkhans are curved both horizontally and vertically. Both slopes are steep; but the steepest, which are sprinkled with powdery sand, are mainly directed towards the south and west. Between the chains of barkhans and the barkhans on the slopes of the mountains there are hollows or grooves (i. e. »troughs between the »waves») of varying size and form. The distribution of the powdery sand in relation to the compact sand is irregular, probably as a consequence of the great number of impediments that exist to the free circulation of the atmosphere, and the division and diverse deflection of the atmospheric currents which ensue therefrom. At all events the layers of powdery sand are always met with on the western and southern slopes, while the compact sand faces east and north. In the depressions the sand is often hard for several paces, but otherwise soft. In some localities compact sand occurs also on the western and southern slopes, a few paces below the crest, and does so even when the slope is 30° to 35°; but higher up, close under the crest, the sand is nearly always powdery.»

»I then climbed to the top of the second ridge of one of the barkhan mountains, and found its absolute altitude to be 630 m.; that is to say, its relative altitude above the belt of sandy eminences at the northern foot of the mountains was 130 m., and above my camp 200 m. The adjacent heights approximated to the same absolute elevation, though in the south I observed some which appeared to be higher; others in the west, at a distance of 1 to 2 versts, appeared to be 30 to 50 m. higher. In all probability the very highest summits of the Kum-tagh reach an altitude of 200 m. above the northern foot of the mountains. On the south side of the first ridge of the barkhan mountains there is a string of broad depressions, crossed by barkhan ridges 2 to 3 sashen high, though seldom as much as 5 sashen, and extending west-north-west, i. e. parallel to the high ridges. The surface, both in these depressions and on the east and south slopes of the barkhan mountains, consists of a layer of dark grey sand, in the form of a small ridge 2 to 3 inches in height. The bulk of the mountains consists on the other hand of fine sand of a dark greyish yellow colour. On the very top of the mountains I found lying on the sand various small objects, blown thither by the wind, such as feathers and fragments of reed-stalks. In the depressions flotsam of that kind is much more abundant, embracing even fragments of mollusc-shells, probably *Cathaica* or *Limnæus;* and there too on the surface of the sand there is in some places a thin sprinkling of fine, rounded gravel. In other localities we perceived salt crystallisations, not only in the depressions, but pretty high up on the slopes where the dark grey sand lies. The sand amongst the salt crystallisations is not only coarser of grain, but is cemented together by salt. These probably represent survivals of old barkhan mountains, over which the sand has subsequently been spread and then been welded together by the salt solutions, which have filtered down through masses of younger sand after being saturated with heavy atmospheric downpours. In the depressions of the first barkhan ridge we frequently came upon small patches of clay, forming a thin crust; these probably owe their origin to the solution of small quantities of clay contained in the sand by atmospheric precipitation, or by the rain and snow bringing down with them the clay dust floating in the atmosphere. Amongst this sand there exist no traces whatever of vegetation . . . From the top of the barkhan mountains I was able to see in the south yet another chain of similar barkhan mountains.»*

This account may be supplemented by the following passage taken from G. E. Grum-Grschimajlo.** »The sandy masses of the Kum-tau present this remarkable feature, that they are at one and the same time perfectly barren and yet immovable. The natives of that region are unable to recall a single instance of these masses of sand ever having moved, or ever having overwhelmed any part of their cultivated fields. Nor during the past ten years do they remember that the crest of the Kum-tau has undergone any perceptible change. And although this last statement is doubtful, it is indisputably true, that these masses of sand have not actually moved. Nevertheless there did exist a time when the Kum-tau did not advance so far into the valley of the Luktschin. The river of Pitschan, which now disappears under the sandy mountains, once flowed in open daylight between Jan-bulak and Dga, and emptied itself into what appears to have been a larger river, namely the Assa, which however dried up a very long time ago. The Kum-tau rises to a very considerable relative height, by estimate probably 450—500 feet. These immense masses of sand are brought thither from a great distance, across the Tus-tau, and arrive from the north-east, while on the south-west they lean upon the mountains of Tschol-tau, the southern boundary of the Turfan depression. How far that belt of sand extends to the east nobody could tell me; but if we regard it as composed of the old dunes of the lake, or rather sea, of Turfan, we shall be warranted in concluding, that their breadth, generally speaking, is not particularly great.»

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* *Op. cit.*, vol. II. pp. 598 ff.

** *Opisanie Puteschestvija v Sapadnij Kitaj*, I. 283.

As compared with Obrutscheff's thorough description, and Grum-Grschimajlo's interesting account, of the Desert of Kum-tagh, Roborovskij's statement is remarkably curtailed. He says, »To the east stretches a zone of sand, embracing the 'cauldron' valley of Luktschin. According to the natives, its barkhans are almost motionless, and as it were 'congealed'. They reach an altitude of 400 feet, and are called Kum-tau.» Then follows a legend in which an ungodly city was condemned by the wrath of heaven to be buried under the sand, and the story of a hunter, who sixty years ago is reported to have discovered in the sand a chest full of gold, with which he lived afterwards in great style. His descendants are still living in Luktschin, and have no reason to complain of being in want!*

I will now quote a few extracts from Bogdanovitsch's conception of the origin of the great accumulations of sand in Central Asia. He says that the climatic agencies of Central Asia are everywhere engaged in creating materials for the formation of sand, and that it is the encircling mountains which contribute the bulk of the material for the regional development of the continental masses of sand. »Thick deposits of fluviatile and lacustrine alluvia from the Jarkent-darja and certain of its tributaries, as well as from the existing (Tschertschen-darja) and former (Kerija-darja and Chotan-darja[?]) rivers, cover immense areas in Central Kaschgaria. There exist proofs beyond all dispute (namely the existence of ancient river-beds) that the lower Jarkent-darja (Tarim) has repeatedly shifted its course. It is evident that these mark the oscillations of the river, and that these oscillations were caused by the accumulation of fluviatile sediment in certain of the beds, and by its constantly increasing removal by the current from others, into which it was originally brought by the same agency. These changes of bed cannot however be connected in any way with more general tectonic processes . . . The fine arenaceous clay deposits from the rivers and lakes, which have been left behind by the rivers when they have shifted their beds, have furnished an abundance of material for æolian formations. The sand which is derived from this fluviatile material is distinguished by the presence of mica, and by its uniform size, its fineness, and its yellow colour, from the coarser, darker and considering the size of the sand-grains, more irregular sand which is derived from other sources . . . The gigantic sand-dunes beside the Jarkent-darja, between Lop-nor (Kara-koschun) and Korla, are built up of products derived from the disintegration of the light, fine-grained clays of the Jarkent-darja.»

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* *Trudij Ekspeditsij Imp. Russ. Geogr. Obschtsch. po Tsentralnoj Asij 1893—95*, I(1) p. 112.

»In Kaschgaria four distinct varieties of barkhan formation may be distinguished: (1) detached, isolated barkhans; (2) barkhan-ridges, or barkhans with their two slopes dissimilar; (3) ridges with their two slopes similar in character; and (4) barkhan accumulations.»

»The first-named, the solitary barkhans, cannot subsist for long. In the process of development their extremities come intimately into contact with each other, so that they coalesce and form long ridges or chains of barkhans. In Kaschgaria the process of cohesion has advanced so far that the sand-dunes there generally present themselves in the form of dune-accumulations . . .»

»Only once did I convince myself by direct personal observation in Kaschgaria that the barkhans, under the influence of the winds blowing persistently in one and the same direction, more slowly but uninterruptedly forwards.»

Bogdanovitsch then goes on to speak of the transformations as to both shape and relief which these same dunes undergo, under the influence of winds from different quarters. Although they remain constantly in identically the same position, their appearance and relief are subject to unceasing change. At Nija and other places he convinced himself, that the crests are turned now in the one direction, now in the other, though at the same time they always preserve a mutual parallelism and adhere to the same base, without experiencing any change of elevation. The connected barkhan-accumulations reach an altitude of 150—200 feet; and are separated from one another by broad trough-like valleys. Bogdanovitsch observed too, that in the north-east of the region, that is next the Tarim, the sand-formation takes place exclusively under the influence of the north-east and east-north-east winds. »Here no winds blow from other directions, and none of the dunes possess similar slopes.» He also made the same observation as I have done, namely that the great altitude (up to 300 feet) of the »barkhan mountains» (i. e. the dune-accumulations) beside the Tarim, and the presence of the broad »valleys» between them, prove that, as soon as the dunes melt together and form dune-accumulations, the forward movement of the masses of sand becomes retarded, while the accumulations begin at the same time to increase in altitude. Bogdanovitsch adds, that Konschin, as the result of his investigations into the dunes of Transcaspia, has arrived at the same conclusions. The extent to which the sand is distributed in East Turkestan, as well as the form and development of the dunes, are to be set down, as Bogdanovitsch rightly observes, solely and alone to the effects of the winds.

The same inquirer then goes on to observe, that the shape and position of the beds of the rivers of East Turkestan exclude the possibility of the contemporaneous origination of the dunes. »The atmospheric disintegration of the older fluviatile deposits gives occasion to the formation of continental masses of sand or barkhans; but the river-dunes, which may have existed in former ages, have been remoulded by the subsequent activity of the wind, and all traces of them are now lost. The only locality in which unambiguous dunes of an older epoch have been preserved is the region of Lop-nor, and the only criterion by which we are enabled to distinguish these dunes from the more recent barkhan-formations is the characteristic orientation which here distinguishes the chains of dunes; nothing else will account for the directions in which they lie, except the arrangement of the shores around the former watery expanse of the Lop-nor.»*

Before proceeding to examine and criticise the above passage, I have yet one other Russian author to quote. South of the Baghrasch-köl stretches a small detached sandy desert which Roborovskij calls the Ak-bel-kum. This he describes from the most northerly point of the southern shore of the lake: The region before us was not very encouraging. Sandy barkhans came down *en échelon* to the shoreline, and even touched the belt of reeds beside the lake; they were still higher than those we met with in the preceding day's march. One of these, the one nearest our night bivouac, reached, according to aneroid measurement, an altitude of 360 feet above the surface of the lake. It took me more than an hour to climb to the top, and I descended, or rather slid down in a sitting posture, in 40 minutes. Even in the lake itself, here and there close to the shore, there were huge barkhans, forming lofty islands, rising to sharp crests, and girdled about with golden reeds. Some of these were already connected with the shore by means of narrow tongues of sand. Others bordered bays in the lake, and occasionally cut off small isolated saline lagoons. Far off in the south were gigantic sandy mountains, rising to an altitude of at least 500 feet above the surface of the lake.»**

There is also a small patch of drift-sand on the eastern shore of the lake. With regard to it Roborovskij says, ›The connected belt of sand which accompanies the southern shore of the lake terminates at its south-east corner in detached barkhans, scattered over the saline soil. But there is another belt of sandy barkhans on the east shore of the lake, about 20 versts long and from 6 to 8 versts broad, bearing the name of Schamal-gansin-kum.*** East of that stretches the long salt tract of Tus, bordered by a high terrace, which in all probability was once the shore of the lake.»†

Both these belts of desert differ in several respects from the Takla-makan. As compared with the immense drift-sand area of East Turkestan, they are but infinitesimal in area, and both are very sharply defined. In this respect they belong to the same category as the Kum-tagh, south of Pitschan, and as the expanse of sand that stretches south of the Basch-kum-köl in northern Tibet, though the latter occupies only a small portion of a large basin. Roborovskij's account fails however to give us any clear information about various important matters connected with the sand's architecture, especially about those which might guide us in attempting to explain the causes which have led to the presence of the Ak-bel-kum on the south and east of the lake, and this circumstance more particularly requires explanation seeing that sand is entirely absent on the opposite northern and western shores. He does indeed tell us, that the dunes on the shore reach an altitude of 360 feet, and that those farther away to the south attain an altitude of at least 500 feet, above the surface of the lake. The altitude of 360 feet was obtained with the aneroid, and is doubtful, because Roborovskij states that the dunes beside the Tschertschen-darja, when measured during the same journey, attained an altitude of 300 feet, which is indeed very much over the mark. The altitude of 500 feet is estimated from the surface of the lake, and is valueless, because we are ignorant both of the distance and of the ascent of the ground in that direction. But his description of the dunes that begin 15 versts north-east of Kimur-chani is more valuable: »Here gigantic dunes have advanced to the very shore of the lake and plunge straight down into its deep and transparent waters. Along the shore extends a narrow belt of thick kamisch, the individual stalks of which reach a height of 3 sashen, and a diameter of about one inch. These reeds led us to consider seriously the possibility of our farther advance. To penetrate into them was impossible: the stalks were so strong, the camels were quite unable to force their way through. Immediately on the right of them rose the steep slopes of the barkhans, and on the left was the deep lake . . . The prevailing winds in this region blow from the south-west, and consequently all the barkhans lay athwart the route we desired to follow, stretching from north-west to south-east, and their north-eastern slopes were very steep.»*

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* *Geologitscheskija Issledovanija v Vostotschnom Turkestane*, pp. 91 ff.

** *Trudij Tibetskoj Ekspeditsij, 1889—90*, III. p. 88.

*** On the map he calls it Schamal-tschansinin-kum.

† *Op. cit.*, p. 89.

The concluding sentence is not quite clear. for if the prevailing winds blow from the south-west, then it would seem to follow almost certainly that the dunes ought to turn their steep slopes for the most part towards the north-east. But the first part of the sentence would seem to indicate that they may also look towards the south-east. With regard to the winds in the neighbourhood of Kara-schahr, I was in 1896 given the following information: »Der vorherrschende Wind soll im Frühling vom Juldus-Thale kommen; im Spätsommer und Herbst ist Ostwind gewöhnlich. Auch jetzt, am 14. März, raste ein ungemein gewaltiger Sturm vom Juldus-Thale, erst um 5 Uhr nachmittags hörte er auf, nachdem er 6 Stunden gedauert und den Weg vom feinen, lockern Staub reingefegt hatte.»**

The wind that comes out of the Juldus valley would blow from the west-north-west. Across the basin of the Baghrasch-köl it would therefore appear that the prevailing winds blow in spring, and come from the west, whereas in the Desert of Lop they blow at the same season from the east and north-east.

Where then do the immense masses of sand in the Ak-bel-kum come from? Are they lacustrine dunes, or are they ordinary desert-dunes, formed in the same way as the dunes in the Takla-makan? With the slender amount of knowledge that we possess with regard to the basin of the Baghrasch-köl it is difficult to answer this question. What excellent material for a physico-geographical monograph a study of that basin would afford! The relations which the basin bears to the ring of mountain-chains which girdle it round, as well as its relations with the Juldus valley, the bathymetrical relations of the lake, its currents, its waves, its floral and

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* *Op. cit.*, p. 87.

** *Peterm. Mitteil.*, Erganzhft. 131, p. 67.

*Ljusti A B Lagrelius & Westphal*

SOLOGHAS, A SMALL OASIS SOUTH-EAST OF KARGHALIK (SE VOL. IV).

In foreground a reservoir for holding up water that sometimes flows down from the mountains. Willows, poplars and a small caravanserai.

its faunal phenomena, its sedimentation by the Chaidu-gol, the deserts on its southern and eastern shores, and the occasions of their origination, the transverse valley of the Kontsche-darja, and the relations which exist between its erosion and the level of the lake — all these suggest fascinating problems that still await solution. And most of them are so intimately connected with the question I have just raised above, that any attempt to answer the latter, until we are possessed of fuller information, can hardly be more than a guess.

After the first glance at Roborovskij's map one is really tempted to make the lake answerable for the origin of the dunes that stand beside it, and so assign to them the same rank and causation as for the dunes that exist on the east side of the Caspian and the east side of the Lake of Aral Indeed in certain respects one even fancies there is a resemblance between these dunes and the coast-dunes of Western Europe, which are also more especially affected by the prevailing south-westerly winds. But in the case of the Baghrasch-köl the relations are in point of fact quite different. The description which Roborovskij gives, both in word and illustration, is quite sufficient, not only to preclude the probability of any such intimate connection, but also to forbid the assumption, that these dunes owe their formation to material derived from lacustrine sedimentary deposits. The longer axis of each dune forms a right angle with the shore line. The steep leeward sides look towards the north-east, and plunge steeply down into the deep parts of the lake, leaving room however for a narrow strip of shore, that appears to be pretty level, and is overgrown with thick impenetrable reeds. This belt of kamisch forms consequently a sharp boundary between the lake and the dunes, and prevents the possibility of direct contact between the dunes and any sandy material there may be in the bottom of the lake. Roborovskij's estimations of altitude — 360 feet near the lake and 500 feet farther to the south — point evidently to an actual rise of the substratum in that direction; for the surface must indeed rise a good deal towards the northern foot of the Chara-teken-ula. And this is all the more probable, when we remember that the southern parts of the lake are deep. Hence it is conceivable, that on the contrary the dunes decrease in height in that direction, and that the loftiest dunes stand on the shore, close to the lake. The village of Kujdalik, at the northern foot of the range, must of course stand in a tract that is perfectly free from sand. If the prevailing winds do blow from the south-west, the dunes ought to increase in height towards the north-east, and the configuration of the shore-line as shown on the map renders it very probable that the direction indicated, the south-west, is indeed that of the prevailing winds. For, while coasts that are dune-beset are specially caracterised by their regular outlines, either perfectly straight or slightly festooned, it is noteworthy that the portion of the southern shore of the Baghrasch-köl upon which the dunes abut is extremely irregular and capricious in outline. In fact, it consists of a succession of bays, projecting headlands, and islands, and some parts of the lake on that side are already entirely cut off by advancing dunes, which sometimes indeed quite encircle them, so that the water in them is salt. A shore-line of this character points unmistakably to an unequal advance of the different masses of sand, that gain ground at the expense of the lake. To judge from these phenomena, the lake on that side cannot be particularly deep; if it were, the advancing ends of the dunes would be washed away, and the material of which they are composed would be dispersed by the movement of the waves and currents, and by the beat of the surf. We have another example of this species of shore-line, formed by the unequal advance of encroaching dunes, on the east side of the Avullu-Tajek-Arka-köl. The fact of the sand of the Ak-bel-kum being highest on the shore of the lake is in agreement with its orientation, for it ought to rise in height towards the centre of the basin, as it does in the Kum-tagh in the basin of the Tarim, and in the belt of sand that lies beside the Basch-kum-köl.

If these dunes derived from the lake the materials of which they are built up, we should expect to find dunes also on the northern and western shores, where the lake is shallow, shallow water being an indispensable condition for the formation of coastal and lacustrine dunes. But on those two sides of the Baghrasch-köl the belt of reeds is broader, and effectively prevents the formation of dunes.

There is however yet another circumstance that lends support to the view, that the Ak-bel-kum would exist in the position it now occupies even though there were no Baghrasch-köl, namely the fact, that in general dunes are much rarer on rising coasts (a negative coastal displacement) than on subsiding coasts. In respect of this Sokolow says: »Somit liegen die meisten Stranddünen an unterwaschenen und infolge davon zurücktretenden Küsten, welche oft zugleich auch noch im Sinken begriffen sind. Sie machen über 90 °o sämtlicher europäischen Stranddünen aus. Unvergleichlich geringer ist die Entwickelung der Dünen an solchen Küsten, deren Aufsteigen als erwiesen angesehen werden kann.»*

The relations indicated in the opening sentence of this passage are those which appear to obtain on the shores of the Baghrasch-köl, that is to say, the water-surface, as compared with the shores, is sinking. Of this we have direct evidence in the sharply outlined terrace that Roborovskij mentions as running parallel with the eastern shore-line, but at a great distance from it. In this process the filling up of the lake-basin with drift-sand, dust, and sediment brought down by the Chaidu-gol plays only an insignificant part; for the deposits of this stream stretch out into the lake in the form of a sharply pointed peninsula. Theoretically the only consequence of this deposition of sediment, and sediment really is deposited, ought to be an increase in the volume of the Kontsche-darja, although the amount of the augmentation is of course excessively small. One indirect effect produced by it should be to enhance the erosive power of the Kontsche-darja as a consequence of its increased volume. And it is precisely this factor of the river's continued erosion — its uninterrupted excavation of the transverse valley between the Tien-schan and the Kuruk-tagh — which continually diminishes and reduces the actual volume of the lake-basin. The process of sedimentation goes on uninterruptedly, and is tending eventually to the total disappearance of the lake. In proportion as the water-area diminishes, the amount of evaporation will decrease, and concurrently with this an increasing quantity of water will find its way into the Kontsche-darja, and this will also enhance proportionally its erosive power. At Kalka, in the transverse valley, there are old riverine terraces at a pretty good height above the level of the existing stream. Now these cannot have been produced by chance heavy rains, because we know as a fact, that the range between the river's high-water level and low-water level varies within only narrow limits in the course of the year; in other words the volume of the stream remains practically unchanged. The accompanying illustration represents the transverse valley at Kalka.

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* N. A. Sokolow, *Die Dünen*, p. 45.

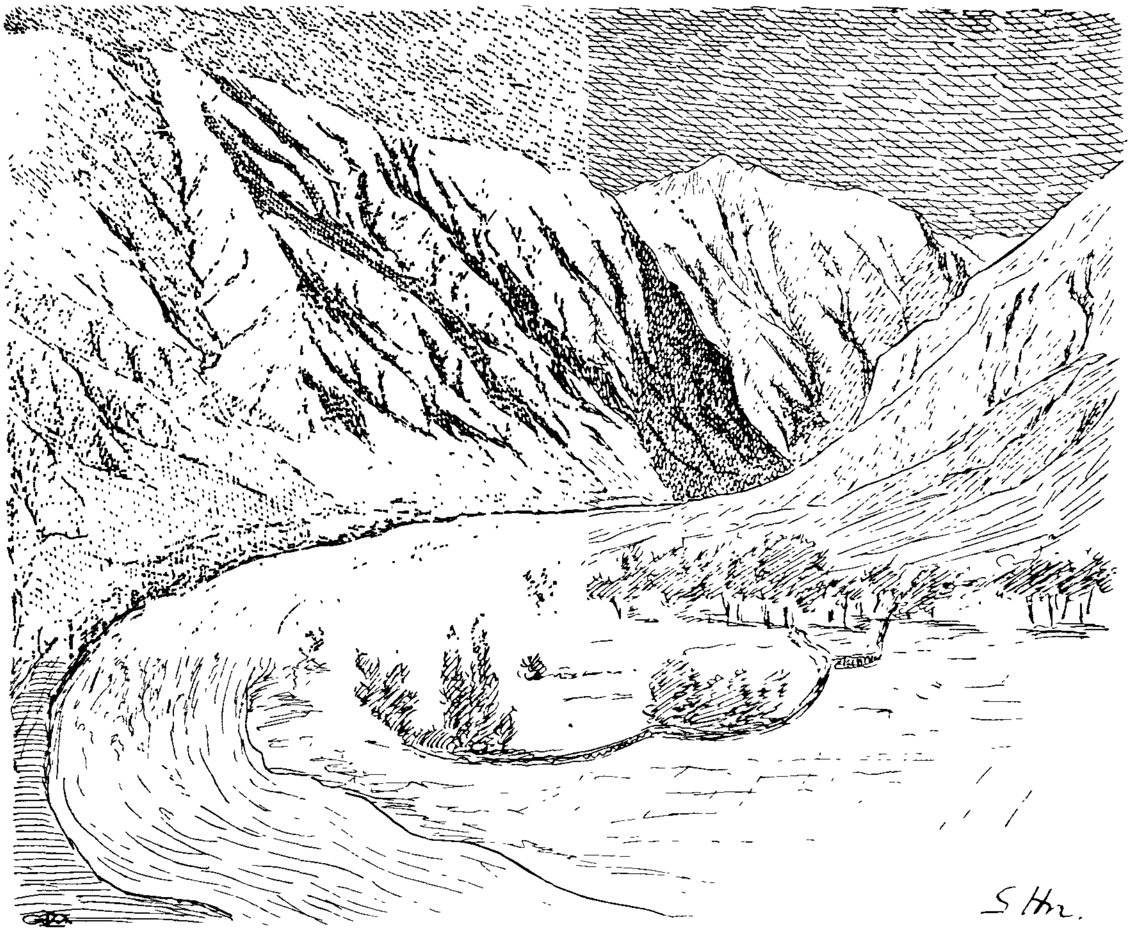

Fig. 177. VIEW OF THE KURUK-TAGH AT KALKA; TOWARDS THE NNW. THE TRANSVERSE VALLEY OF THE KONTSCHE-DARJA COMING DOWN FROM BAGHRASCH-KOL.

Since then the surface of the lake is constantly subsiding, the substratum upon which the Ak-bel-kum rests tends to grow relatively higher, and to lift itself terrace-like above the lake. The lake-dunes must advance very slowly towards the north-east, if it is the fact, as is stated, that the eastern part of the lake is deep; while on the other hand the leeward slope would be prolonged considerably under the water, and the nearer the dunes approach to the deep parts of the lake the slower will be their forward movement. If the water-level $a$—$a$ (see fig. 178) drops after a certain time as low as $b$—$b$, and during the same period the dune $A$—$A'$—$A''$ advances to $B$—$B'$—$B''$, then in the latter case the leeward side will have been proportionally prolonged. Whilst this is taking place, the kamisch-grown abrasion terrace $A'$ travels to $B'$, describing a line which horizontally is directed towards the north-east, but vertically sinks downwards. The net result is shown in profile in fig. 179, the firm substratum forming a level and gently sloping plain, the lower edge of which reaches down to the *pro tempore* shore-line. In consequence of this downward slope, the southern dunes may appear to the eye to be higher than those to the north, but in reality it is the fact of the substratum being distinctly higher than the lake which in the first instance makes the dunes appear higher. It is conceivable, that it is the shrinking of the lake which renders it possible for the dunes to advance rather than any actual movement of their own that carries them to the north-east. Every step, no matter how small, that the shore-line takes towards the north or north-east, it draws after it the leeward side of the nearest dunes. In the course of time the storm-driven drift-sand has without doubt formed relatively shallow sub-aqueous banks, upon which the forerunners of the advancing dunes establish themselves.

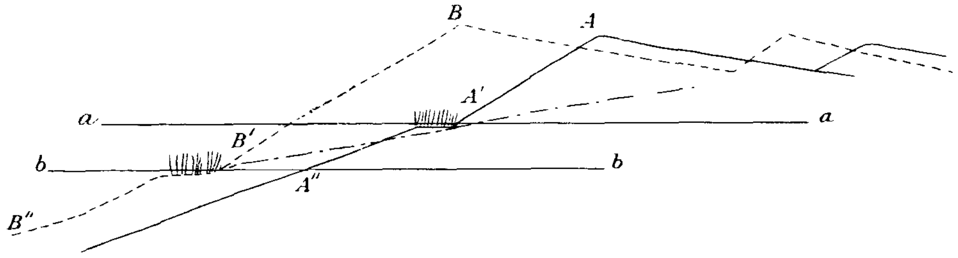

Fig. 178.

In consequence of the negative displacement of the shore-line narrow strips of the lake-bottom are of course successively exposed, and from these strips a certain amount of sand is blown up and added to the dunes. Nevertheless the amount of sand derived from this source is infinitesimally small as compared with that which is derived from the disintegrated products of the circumjacent mountain-ranges. And it is to this conclusion that the whole of the above reasoning points, namely that the dunes of the Ak-bel-kum are not derived from lacustrine sediment, but are continental dunes, maintained by the continuous disintegration of the mountain-range. As such they will not only retain their existing positions, but will also overwhelm the former lake-basin on the north and north-east of the existing Ak-bel-kum after the lake has totally disappeared. When that occurs, the sand-filled basin will belong to the same category as the Kum-tagh does now.

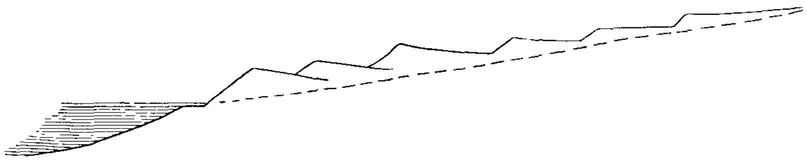

Fig. 179

I have purposely discussed this little desert by itself because of the special position it occupies in consequence of its proximity to the lake, and because it does not directly touch the questions which I am now about to consider. But before I proceed to discuss them, I will add yet two other passages taken from Loczy's excellent and exhaustive work, dealing with the sandy deserts in western Kan-su, and especially in the region of Tung-hoan:

»Schon von Fu-ye-ye an führt der Weg zwischen Sandhügeln hin, die im Allgemeinen sehr kurze, halbmondförmige Barkhane von OW.-licher (genauer ONO.—WSW.-licher) Richtung sind; ihre Steilseiten sind gegen Süden gewendet und ihre Kämme scharf; dieselben sind durchschnittlich 14—18 Mtr. hoch und erreichen nur ausnahmsweise eine Höhe von 50 Mtr. Zwischen Kan-tschou und Kan-tja bewegt sich der Sand über dem Lössboden, welch letzterer auffallend harte und gänzlich vegetationslose Flächen darbietet . . . Der bei Kau-tja-shien vorkommende Sand ist von gelblich-grauer Farbe und grobem, mitunter erbsengrossen Korn. Im Übrigen ist der Sand sehr rein und ist Thon und Staub sehr wenig in ihm enthalten; es besteht derselbe zumeist aus glatt abgerundeten Quartz- und dunkeln Quartzit-Körnern, doch fehlen darunter selbst dunkle Kalksteinfragmente nicht . . .

Die Form und die Gruppirung der in der Ebene auftretenden Sandwehungen sind unregelmässig. Solche wohl entwickelte Dünenreihen und halbmondförmige Barchane, wie sie Forsyth aus der Gegend von Kaschgar, und Muschketow aus dem W.-lichen Turkestan beschrieben hat, sah ich hier nirgends. Es steht den Luftströmungen eine solche Menge von Flussbetten, Oasen, Bewässerungskanälen und Stadtmauern im Wege, dass hierdurch ihre normale Richtung abgeändert wird und sich infolge dessen auch die Entwickelung der Barchane unregelmässiger gestaltet, wie in solchen Wüsten, die in grösserer Entfernung von Gebirgen liegen und nicht so dicht von Flussläufen durchschnitten sind, wie der in der Provinz Kan-su gelegene Teil der Gobi. Trotzdem verraten die bei Kan-tschou befindlichen Sandhügel durch ihre im Allgemeinen NO.—SW.-liche Längenrichtung und ihre nach SO. gelegenen Steilseiten deutlich die herrschende Windrichtung . . . In der Nähe von Tung-hoan wird der Sand beinahe bis zur selben Höhe hinaufgetrieben, wie die höchsten Gipfel des Ta-pan-shan-Gebirges. — Selbst jene Sandberge, die in der Nähe von Tung-hoan die üppigen Saaten der Oase begrenzen und den kleinen malerischen Yü-ya-tshwan-See umgeben, erreichen bereits eine Höhe von 150—180 Meter, die weiter einwärts gelegenen dagegen sogar eine relative Höhe von 500 Mtr. über der Stadt Tung-hoan. Diese Sandhügel bestehen aus zeltförmigen Querrücken, die von scharfen von N. nach S. laufenden Kämmen gekrönt werden. Das Wandern des Sandes schreitet gegen Osten zu vor, wo auch die Steilseiten der Hügel hinblicken. Als wir den von einem Wäldchen umgebenen See Yü-ya-tshwan inmitten der Flugsandhügel aufsuchten, rutschte der von unseren Begleitern aufgerührte Sand vom Kamm der Steilseite W.-lich des Teiches lawinenartig herab und verursachte durch seine Bewegung ein eigenthümliches dumpfes Rollen. — Es sind dies die Ming-sha-shan oder die sogenannten dröhnenden Sandberge.«*

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* Loczy gives numerous other details about the movements and other properties of the sand, which are too long to quote, e. g. the heaping up against the town-walls of An-si. See *Die wissenschaftlichen Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien 1877—80*, I. pp. 507 ff.

# CHAPTER XXVII.

## ALTITUDE OF DUNES, MOVEMENTS OF DUNE-MASSES.

My object in quoting *verbatim* the passages given in the preceding chapter was to afford some conception of certain other desert regions in the interior of Asia, with the purpose of showing that the Desert of Takla-makan occupies in many respects a peculiar position amongst them, and that with regard to its area, its unbroken continuity, and the volume of its sand it is not surpassed by any other Asiatic desert, nor indeed, so far as I know, by any other sandy desert in the world. In point of area alone it has formidable rivals in the Kara-kum and Kisil-kum, in Transcaspia; and with regard to the altitude of the dunes, the figures quoted by Obrutscheff, Roborovskij, and Loczy are considerably higher than those I obtained for the Takla-makan. In this connection it is however but fair to point out, that the maximum value of 89.5 m. that I obtained in the north-eastern part of the Takla-makan (Desert of Tschertschen) is based upon exact measurements of level, whereas the travellers I have just named either used an aneroid or estimated the height by eyesight alone. Now both these methods of measurement are of doubtful value, especially the latter, and certainly they are no longer applicable when we desire to ascertain the absolute limits of altitude to which an accumulation of sand-dunes is capable of attaining. Loczy's statement, that the dunes have a relative altitude of 500 m. above Tung-hoan gives us no real information about the actual altitude of the dunes that really consist of wind-driven drift-sand, or in other words, about the height at which the base of the dunes lies above Tung-hoan, for it is of course from this base that the real height of the dunes should be reckoned. Loczy can hardly mean, that the actual dunes themselves attain an altitude of 500 m. The value of 200 m. which Obrutscheff gives as being the altitude of the dunes of the Kum-tagh approaches close to the maximum height hitherto ascertained for dunes in any part of the world. Sokolow says:

„Ihrer Höhe nach übertreffen die Wüstendünen, wenigstens diejenigen der Sahara, bei weitem die Stranddünen und erreichen oft eine für Windbildungen in der That erstaunliche Höhe von 200 m. [*] In his description of the Erg in Sahara

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[*] *Op. cit.*, p. 180.

Rolland gives some heights of dunes: »La hauteur de ces accumulations de sable au-dessus du sol ne dépasse généralement pas 150 à 200 mètres; dans certaines régions, elle atteint des chiffres plus élevés: les plus hautes dunes de l'Erg oriental, au Sud-est de ce groupe, non loin de Ghadamès, auraient, d'après M. Largeau, jusqu' à 500 mètres et davantage». However the altitudes just mentioned do not seem to rely upon precise measurement. When speaking of the individual dunes and the accumulations of dunes, which he has seen himself, Rolland gives altitudes which much better agree with the heights I obtained by measurement: »Dans les chaînes que j'ai vues au Sahara, la hauteur des dunes élémentaires, faisant saillie au milieu d'une chaîne, ne dépasse généralement pas une vingtaine de mètres. La hauteur des mamelons de dunes groupées en ghourd est souvent de plus de 100 mètres; je citerai, à une journée au Sud d'El-Goléa, le piton de sable isolé du Gueurn el-Chouf, haut de 70 mètres, et, non loin de lui, le piton du Gueurn Abd el-Kader, isolé également et plus élevé encore».* By way of comparison I may add, that the sandy mountain beside the Soda Lake in Fezzan is considered to be 160 m. high (Supan). »In den Gegenden, wo der Passatwind herrscht, erreichen sie bisweilen bedeutende Höhen, so an den madagasischen und tunesischen Küsten 140 m. und mehr. An den südspanischen und den gascognischen Küsten können sie 90, an den holländischen 60, an den jütländischen 30 und auf der kurischen Nehrung 70 M. Höhe erreichen.«**

On the other hand the two drift-sand regions in which Obrutscheff and Loczy found their high dunes are both extremely small in area as compared with the Takla-makan. Since now in both cases alike the dunes are twice as high as those of the Takla-makan, the question arises: Why is it dunes equally high do not occur in this desert, seeing that the requisite material, sand, is already existent in inconceivable quantity? As the architecture, structure, and form of the dunes are all due to the activity of the wind, the differences in height must likewise be ascribed to the effects of the wind: that is, the winds that blow in the desert of Kum-tagh and in the district of Tung-hoan must be different from the winds that blow in the Desert of Lop and the Desert of Tschertschen. And there is nothing surprising in the fact that the wind-relations of the Kum-tagh should be different from those that obtain in the Desert of Lop, because the ranges of the Tschöl-tagh and the Kuruk-tagh, and the swelling which intervenes between them, separate the one desert from the other; besides which, the arrangement of the sand in the Ak-bel-kum points unmistakably to the existence of winds diverse from those of the Lop country. In the region of Tung-hoan however it might reasonably have been expected, that the winds would have been the same as, or at any rate similar to, those that prevail in the country of Lop; but in point of fact different winds seem to prevail there also.

Potanin is quite right when, in the passage quoted in the last chapter, he observes, that it would be very interesting to have a map embracing all the deserts of Central Asia; yet how greatly such a map would gain in both value and interest, if it were possible to indicate on it by means of arrows the directions from which the prevailing winds blow throughout the same region! A map of the deserts alone would be merely a lifeless photograph of bare facts, — a skeleton — telling us only that in such and such regions deserts exist, whereas with the addition of wind-arrows the map would at once acquire vitality, and we should then understand *how* those several deserts originated, and *why* it is that for countless centuries those several masses of sand have gone on heaping themselves up in the very regions in which we now find them. The result would be not only an illustration of one of the most magnificent instances in existence of the eternal and unchangeable association of the atmosphere with the surface of the earth, but also a proof of the effects produced by regular winds upon the part of the earth's surface across which their arid breath passes. Peschel wrote as follows as long ago as 1869: Ehe die Luftströmungen die Küste der Sahara erreichen, haben sie sich durch die turanischen Steppen Innerasiens, über das iranische Hochland, über Nordarabien und über alle Wüsten westlich vom Nil bewegt. Die geringen Wasserdünste, die sie mit sich führen, stammen aus dem asiatischen Eismeer, und nachdem sie die sibirischen Wälder benetzt, im Winter die Kirgisenweiden mit Schnee überschüttet, lassen sie, ihren Weg nach Südwest und West fortsetzend, fast nur pflanzenleere Wüsten hinter sich. Die Kette von schattenlosen oder gänzlich kahlen Räumen, die auf der nördlichen Halbkugel von der barabinskischen Steppe bis zum atlantischen Saum der Sahara im Zusammenhang sich fortzieht, ist nichts Anderes als das trockene Bett jenes Luftstromes, den wir den Nordostpassat nennen.«*

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* Georges Rolland, *Géologie du Sahara Algérien*, pp. 212, 214.

** Arrhenius, *Lehrbuch der kosmischen Physik*, II. p. 769.

And even though the progress of knowledge with regard to the surface of the earth lays this passage open to modification in detail, the thought which underlies it is nevertheless very instructive.

The idea that all dunes, no matter what category they belong to, are produced by the agency of wind is an old and well-established truth, that has been repeated hundreds of times in the text-books of geography and geology. Penck gives expression to it in the following words: »Dünen entstehen überall dort, wo der Wind ein leicht bewegliches, nackt daliegendes Material vorfindet, welches zu grobkörnig ist, um im allgemeinen hoch in die Luft erhoben zu werden, das aber bei lebhafter Luftbewegung sofort fortgeweht wird«;** while Fritsch lays down the following simple laws for the formation of dunes in general: »Die Dünenbildung setzt voraus: 1) Vorhandensein eines geeigneten Sandes, bez. fortdauernde Bildung eines solchen. 2) Existenz eines herrschenden Windes, welcher die gleichmässige Anordnung des Sandes bedingt. 3) Abwesenheit einer bedeutenden Walddecke oder einer den Boden durchfeuchtenden Flüssigkeitsmenge, durch deren Einwirkung die Sandkörner an der Erdoberfläche durch Kapillaranziehung festgehalten werden.***

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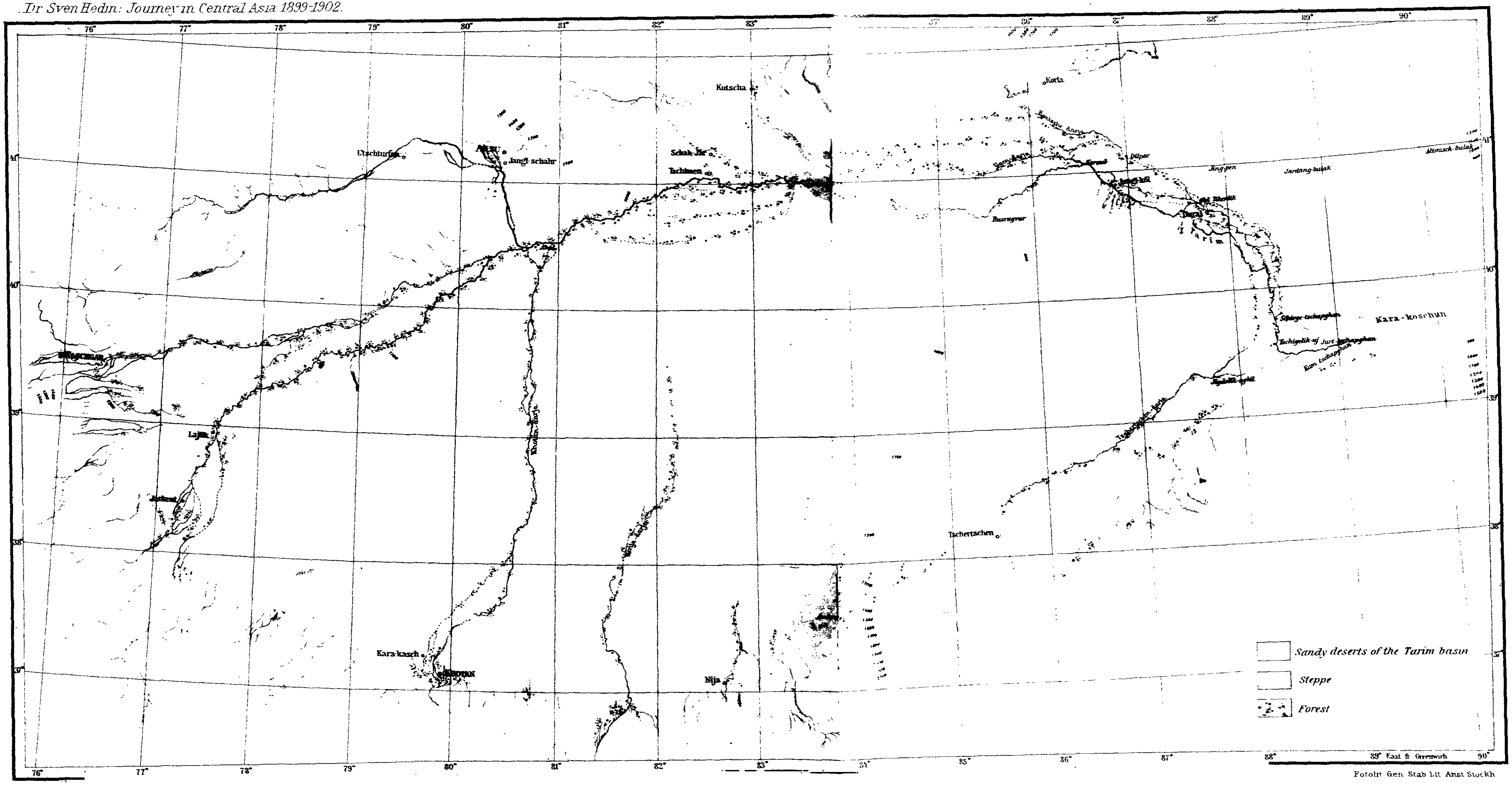
* *Neue Probleme der vergleichenden Erdkunde*, p. 183.

** *Morphologie der Erdoberflache*, I. p. 250.

*** What Rolland says of the rôle the climate plays relatively to the formation of the dunes of the Sahara may also be said with regard to all other dune-regions: »On sait que le climat saharien est caractérisé par l'absence presque complète de pluie. Pas d'humidité, pas de végétation; rien qui fixe les matières meubles. C'est en quoi le climat joue un rôle décisif dans la formation des dunes ..... C'est à son climat, a dit M. Duveyrier, que le Sahara doit d'être le Sahara; j'ajouterai: et d'avoir des dunes. L'âge des dunes n'est autre que l'âge du climat saharien; elles ont commencé à se former quand l'extrême sécheresse de l'époque actuelle y a succédé à l'humidité de l'époque quaternaire.» (*Géologie du Sahara Algérien*, p. 218).

Dr Sven Hedin: Journey in Central Asia 1899-1902.

Pl. 44 a.



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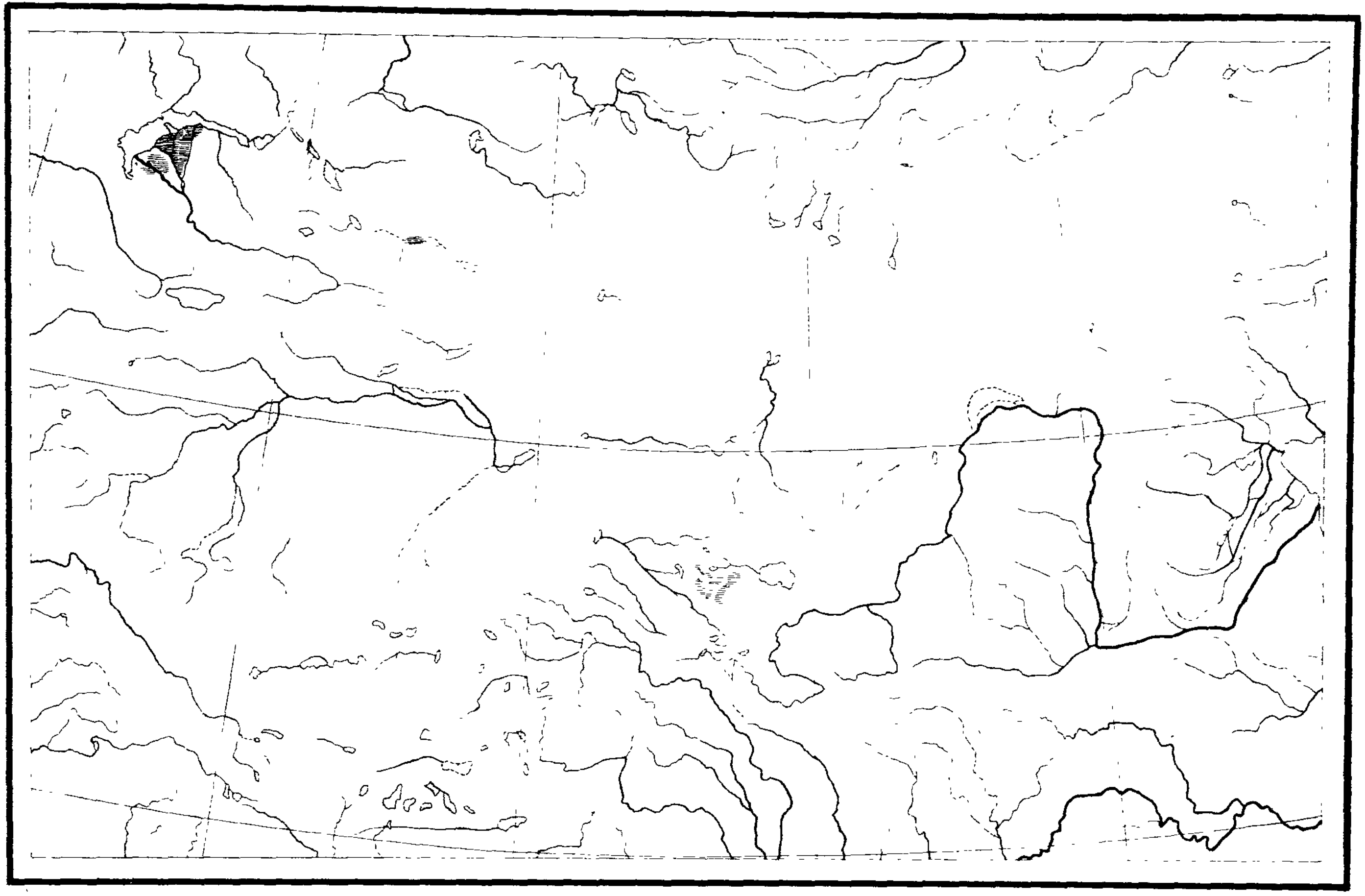

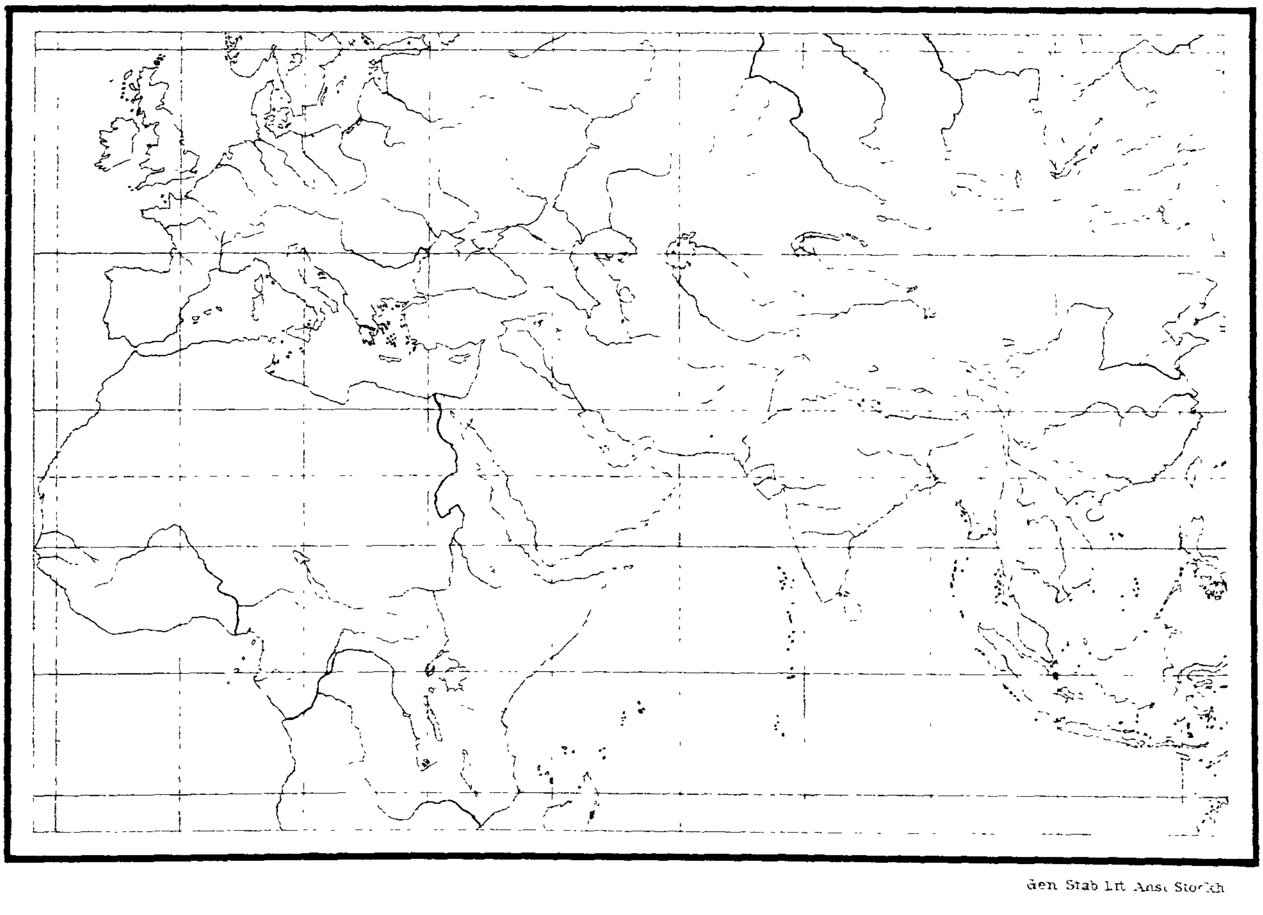

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— Wo der Wind nicht ausschliesslich oder vorwiegend aus einer Richtung weht, bilden sich mehr rundliche und öfters wechselnde Sandhügel, bisweilen auch fast ebene Sandflächen.»*

All these conditions are abundantly fulfilled for Central Asia, and the deviations in the shape of the dunes, which Fritsch says arise when the winds are not constant, are precisely what we find in the Kum-tagh and in the desert at Tung-hoan. The heaping up of exceptionally big dunes on a relatively small area like the Kum-tagh must be due to the fact, that there are there no prevailing winds, that is to say, to the fact that the winds vary, and that the winds which blow from the various directions counterbalance one another in force. To some extent however the north-east wind would appear to be rather the strongest, for while Grum-Grschimajlo tells us that the natives have never observed the slightest tendency on the part of the dunes to advance, he himself states that the river of Pitschan once flowed between Jan-bulak and Dga and emptied itself into the Assa, and that its bed is now buried under the sand. Now this does of course imply an advance of the dunes, and an advance moreover towards the south-west or west-south-west.

In the desert of Ak-bel-kum we have found that the south-west winds prevail as a matter of course, and consequently the dunes extend from north-west to south-east. It would therefore appear that in this desert the relief and architecture are more homogeneous, whereas the Kum-tagh appears to consist of a single accumulation of sand, composed of course of countless individual dunes that have climbed up over each other in such a way that the relative altitude increases towards the centre of the sandy area. The great difference between the Desert of Tschertschen and the Kum-tagh lies therefore in this: in the first-named the effective winds keep sweeping across it in the same fixed direction, the consequence being that the dune-accumulations taken as a whole all have approximately the same relative altitude and the same perpetually recurring relief; further, that the masses of sand themselves travel unceasingly towards the west-south-west, and the oscillating paths they may chance to follow under the influence of other winds produce no effect whatever upon the general relief of the desert; whereas in the Kum-tagh the winds are on the contrary so irregular that no uniform type of relief has ever been able to develop, because no sooner are the masses of sand disposed in one direction by a given wind than they are shortly driven back again by another wind. blowing from the very opposite direction. That part of the depression of Luktschin which is filled with sand is therefore a sort of sink or lumber-room into which the disintegration products of the encircling mountains find their way before the winds that blow from every quarter except the west. and in this way help to augment the general mass of the dunes. If any one wind were here decisively predominant over the rest, the sand would overwhelm the region to the leeward. Nor would the proximity of the mountains offer any hindrance to this process. because the dunes are able to a certain degree to climb up the slopes of the mountains, as we have seen them do, for example, up the slopes of the Tusluk-tagh in the west of East

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* *Allgemeine Geologie*, p. 209.

Turkestan, and as we shall see they also do in that part of the Desert of Gobi which lies immediately west of Sa-tscheo.

Before leaving this question of the altitude of the dunes, I will once more emphasise the fact of the remarkable uniformity which in this respect characterises the summits of the chains of dunes in the Desert of Tschertschen; if any of them do overtop their neighbours, it is by a trifle only, seldom more than 10 to 15 m. Viewed from the top of the 89.5 m. high dune, the other dunes in the vicinity may thus present a few summits that ascend as high as about 100 m., but on the whole the value of the maximum elevation of the different ranges varies but slightly. Notwithstanding the immense quantities of sand which have accumulated in the desert, the dune-ranges seem unable to rise above a certain definite altitude, and whenever from any cause the sand does anywhere ascend above that limit the wind soon succeeds in levelling it down again to the usual average maximum height. It is a phenomenon cognate with what Penck calls »the absolute upper limit of denudation». According to him, no mountain-peak is able to rise above this theoretical level, for the simple reason that, before it can attain it, it is reduced by denudation to the level indicated. But whereas this phenomenon is causally associated with the entire body of climatic factors and agencies of disintegration, the maximum altitude of the dunes (assuming of course that the same conditions obtain which we find in the Desert of Tschertschen) is practically dependent upon the wind alone, i. e. its direction and its force. Sokolow recalls the fact that Jordan, after a violent storm in the Libyan Desert, observed how the summit of a dune was lowered 0.22 m., and after the simoom had been blowing a day and a half it was lowered 1 m.; and he then adds: »Es steht ausser Zweifel, dass es auch bei Wüstendünen eine Grenzhöhe giebt, über welche hinaus sie nicht zu wachsen vermögen, wie unerschöpflich der Sandvorrat, der zu ihrem Unterhalt dient, auch sein möge.»* Precisely the same view is expressed by Cornish, who says: »A permanent dune is so large that the wind never holds sufficiently long to obliterate the effects of former winds. — Thus size alone may make a dune a permanent hill, even if it be composed of loose sand throughout. Given a constant climate, a large desert dune might conceivably outlast the highest mountains, for the denuding agent renews the surface. On the other hand, there is a necessary limitation of the process by which dunes grow, which prevents their attaining heights equal to those of mountains formed by erosion. The winds have greater power at considerable elevation than near the surface of the ground, so that, even if a group of sand-hills of excessive height were piled up artificially, more sand would be removed from the summits than the wind would bring, and this lowering of the summits would not be compensated by the deepening of the troughs, the work of the wind at the summits being assisted, and that in the troughs being hindered, by gravity.»**

It is difficult to determine how far the altitudes of the dunes in the Desert of Tschertschen are affected by special circumstances due to hydrographical changes that have taken place since the Tarim ceased to empty into the Lop-nor. The new position that the river has assumed, and the pretty broad belt of vegetation, by its binding and retarding effect, no doubt check the supply of sand, so that the dune-crests in the extreme north-east must tend to be lowered rather than raised. Suppose the river to maintain its position at some given point *A* (fig. 180), then the ranges of dunes should advance away from it and the sand-free belt *A*—$A_1$ should increase in breadth. Nevertheless the height of the dunes is not likely to decrease to any very appreciable extent, because the sand that belongs to each dune-accumulation can never get away from it by blowing over to the nearest neighbouring range to the leeward. On the other hand we have seen that the river travels in the same direction at an even faster rate than the dunes do.

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* *Op. cit.*, p. 180.

** *On the Formation of Sand-dunes*, by Vaughan Cornish, in *Geog. Journal*, March 1897, p. 285.

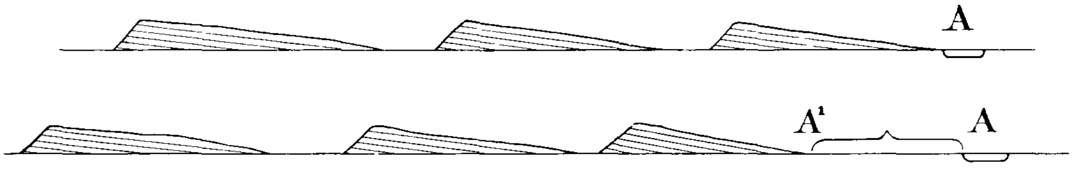

Fig. 180

These relations could however only prevail in a desert like the eastern Takla-makan, where a constant wind prevails, where the surface is level and barren, where the supply of sand has been, at least up to the present time, uninterrupted, and where, finally, all these factors unite to produce a regular and stereotyped effect. In the Kum-tagh the result must be quite different. There the altitude of the dunes is relatively independent of the wind; in fact the limits of their altitude can hardly be determined by anything else except the laws of gravity. And in the course of time their height will no doubt be increased by the supplies of sand which the winds are continually bringing from different directions.

When I wrote the chapter in vol. I of this work, that treats of the marginal lakes of the Tarim and of the Desert of Tschertschen, I had had neither time nor opportunity to make myself *au fait* with the existing phase of the study of dunes, or even to master the results arrived at by other investigators who have visited sandy deserts in other parts of the world. If that was a defect and an omission on my part, I have herewith endeavoured to remedy it by devoting further attention to the question now, although I have not of course been able to do more than refer to a few out of the many studies and examples that exist. From one point of view, I do not consider that it was a defect in my description of the Desert of Tschertschen, that I confined myself entirely to my own observations and disregarded the results arrived at by other investigators. By so doing my discussion may claim to be entirely original and unaffected by the views of others, and above all my conceptions cannot be said to be biassed by any overgreat deference to mere authority.

Upon comparing my observations with those of other investigators, I am the more rejoiced to find upon most points a close agreement between us. It is only in respect of two or three factors of minor significance that I have reached results of variance with those of other inquirers. I need hardly say, that no unconditional comparison can be made between the eastern Takla-makan and the sandy expanses of the Sahara, because the wind-relations in the two deserts are palpably very different. In the ensuing pages I propose to discuss briefly one or two of the most important problems connected with the formation of dunes.

Let us in the first place consider the movement of continental dune-masses. With regard to this there exist, as is well known, two divergent opinions — one that such dunes do travel, the other that they do not. The defenders of the latter opinion go to the Sahara for their illustrations. There certain drift-sand areas have from the remotest times occupied the same positions that they occupy now, and neither names, oases, nor wells have changed their situation for as far back as the memory of man can reach. So far as I understand, the individual dunes in a sandy region such as that are however subject to precisely the same laws as those which obtain, for example, in the Desert of Tschertschen. That is to say, they must move in the direction of the wind, and often at a rapid rate; but the whole of the secret is this, that at another season of the year they are driven back by winds blowing from the opposite direction. They do travel therefore, but instead of travelling always in identically the same direction, they move backwards and forwards. The area upon which these oscillating movements take place, that is to say the continuous mass of drift-sand itself, is however motionless, because its borders are little if at all crossed by the migratory dunes. The particles or grains of sand which make up the lowest and the central parts of a drift-sand area such as this have for centuries upon centuries been quiescent and stationary; on the other hand their superficial or exterior parts, exposed as they are to the wind, are incessantly in movement. Figs. 181 and 182 will make the situation clear. In the former the curved lines indicate the oscillations of the sand-grains, and they become rapidly shorter towards the centre; while the latter shows distinctly, how the separate dunes change their form and direction, without however altering their position.*

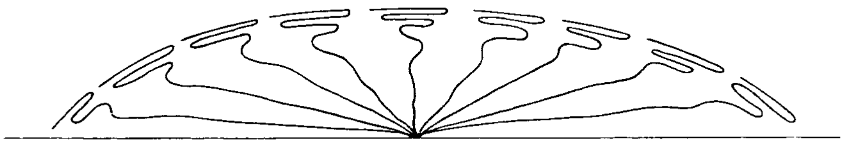

Fig. 181.

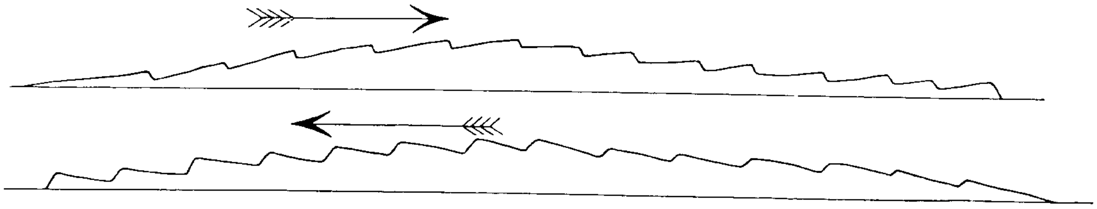

Fig. 182.

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* I cannot help citing a very interesting passage from Rolland's excellent work, which illustrates in the minutest detail what I have said above regarding the desert-type of, for instance, the Kum-tagh of Luktschin: L'ouragan le plus violent, au milieu des grandes dunes, les fait *fumer*, mais ne les remue que sur une bien faible épaisseur. Le spectacle est effrayant, l'impression des plus pénibles, le danger réel; les sables obscurissent l'air et cinglent le visage; ils remplissent les yeux, la bouche, les oreilles: ils altèrent le gosier et dessèchent les peaux de bouc des caravanes indigènes, menacées de périr de soif. Mais quand le calme renaît, on retrouve les choses en l'état, et les mêmes hauteurs aux mêmes

According to Sokolow all observers from Central Asia and the Sahara are agreed, that the separate individual dunes move incomparably faster than the chains of dunes, i. e. the dune-accumulations built up by the coalescing together of several individual dunes. Speaking of the relations which the dune-mass bears in general to the rate of movement, he says — what indeed I also laid down in the first volume — that «das Vorrücken der Düne verläuft, bei sonst gleichen Bedingungen, um so rascher, je grösser der Wind und je geringer das Volum der Düne ist.» *

According to Konschin, the rate of movement is directly proportional to the force of the wind and conversely proportional to the mass of the dune. The part which is played by the mass of the dune becomes evident from the following calculation made by Konschin: «So wurde ein Barchan von 10 m. Länge, 5.5 m. Breite und 0.3 m. Höhe in 24 Stunden bei sehr starkem Winde von 11 bis 17 m. in der Sekunde um 20 m. fortbewegt, während ein anderer 20.1 m. langer, 13.5 m. breiter und 0.9 m. hoher Barchan am selben Tage nur um 9.2 m. verschoben wurde.»**

If the same proportions hold good for dunes of considerably greater dimensions, the dune-accumulations in the north-east of the Desert of Tschertschen would not move at the rate of more than 1 to 2 dm. in the 24 hours. Konschin says also, that the chains of barkhans do not advance more than 2 m. in the course of the year. Although I am unable to appeal to any precise measurements, I have taken it, that the dune-accumulations in the north-east of the Desert of Tschertschen advance about 1 m. westwards in the year, a value which is too high rather than too low; but, taking into account the constancy and force of the wind, and the fact that its strength increases with the altitude — and in the case of these dune-masses this last is an important factor — taking these things into account, the figure I have just

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places. — Un vent suffisamment prolongé oriente et fait peu à peu rouler, suivant sa direction, les petites dunes ayant 10 mètres au maximum; il peut y avoir ainsi avancement de quelques mètres. Mais, comme aucun vent ne domine autant au Sahara que le vent de mer sur une côte, comme, au désert, les vents changent, avec les saisons, il y a ensuite recul, et ces mouvements inverses s'équivalent à peu près, de sorte qu'en fin de compte, il n'y a guère de déplacement. — Quant aux grandes dunes, leur masse est à peu près immobile, et leur couverte seule se déplace sous l'action du vent. Le vent n'a pour ainsi dire que le temps d'orienter les dunes élémentaires; puis il change, les écrête, retourne leurs pics, les modèle à nouveau, etc.: avec lui changent également les zigzags capricieux des dunes composées de plurieurs sioufs enchevêtrés. Pour les dunes plus importantes et pour les groupes de dunes, l'orientation peut varier suivant l'époque, d'autant moins d'ailleurs qu'il s'agit d'un amas plus considérable; pour les grandes dunes proprement dites, elle ne fait qu'osciller plus ou moins autour de la résultante mécanique des vents: enfin, pour les grands massifs, elle est à peu près constante, l'oudjh du grand Erg, c'est-à-dire son versant raide, formant toujours lisière du même côté et faisant toujours face au Sahara dans la même direction. — Ainsi la physionomie des grandes dunes change, la configuration de la surface se modifie réellement, la forme des ensembles subit des oscillations périodiques; mais, en somme, l'emplacement des massifs et l'orographie des chaînes ne varient guère; témoin, dans les grandes dunes, la permanence des pistes de caravanes suivant les lisières des *gassi;* témoin l'existence de points d'eau connus de longue date au milieu des sables, comme l'Aïn el-Taïba; témoins les noms attribués aux chaînes et à leurs intervalles, à tel sommet et à tel col, et même à de grandes dunes isolées, comme le Gueurn el-Chouf et le Gueurn Abd-el-Kader; témoins les oasis du Souf, subsistant en pleine région de l'Erg, entre de grandes chaînes de sable et à leur pied même; témoins les vieux troncs d'arbres que l'on rencontre dans les grandes dunes et souvent sur leurs sommets, etc.» (*Géologie du Sahara Algérien*, p. 225) It would not be difficult to cite, from the works of the great French and German explorers in North Africa, many other examples pointing to the same conclusion, but for our present purpose the above citation may be regarded as quite sufficient.

* *Op. cit.*, p. 104.

** Sokolow, *Die Dunen*, p. 263.

quoted as the rate of annual advance in the north-eastern part of the Desert of Tschertschen *may* be pretty near the actual rate.

In the case of the crescentic individual dunes the two wings are pushed forward in the direction of the wind at a faster rate than the main mass of the dune, and faster also than its crown, a circumstance which is in full agreement with the law laid down as to the relation that exists between the rate of advance and the mass. But in the case of the accumulations built up of countless separate individual dunes the relations are different. It is precisely because they have coalesced together into a homogeneous conglomeration of individual dunes that their individualistic properties no longer come into play; but their laws of movement, like the paths taken by the winds, are more complicated. We no longer find wings shooting on ahead faster than the main mass. Any individual dune, that at a relatively great rate climbs up to the crest of a dune-accumulation, entirely loses its individuality upon passing over to the leeward side of the accumulation. And probably under these complicated circumstances the law governing the proportion of rate of movement to mass does not always hold good with the same degree of certainty. If on the crest of any such dune-accumulation there happens to be formed a swelling or hump, which we may call *A*, then the wind possesses greater power at that spot than it does at *B* or *C*, which are situated lower. The sand is there more exposed, that is less compact, and less sheltered; hence it is conceivable that such spots will advance at a more rapid rate. But if this is the case, it will not be long before *A* is levelled down by the wind to the same elevation as *B* and *C*. And a similar process is repeated on every swelling throughout the whole of the long crest, the result being that the advance takes place by, as it were, irregular forward jerks, though, when the line is considered as a whole, the advance is tolerably even throughout, the only exceptions being the places where cross-thresholds occur.

There exist in fact too many proofs of the *de facto* progressive movement of continental dune-masses for anybody seriously to doubt it. Most beautiful examples may be seen in those parts of the desert that are crossed by the Trans-Caspian Railway. With regard to them Walther writes as follows, his words suggesting also an interesting parallel with the conditions that obtain beside the lower Tarim, as well as a proof of the part which large bodies of water play in the disposition of sta- tionary drift-sand:

> Mit einer Geschwindigkeit von 20 m. an einem stürmischen Tage wandern einzelne Sandberge nach Süden; aber die Durchschnittsgeschwindigkeit des Sandmeeres scheint nur etwa 6 m. pro Jahr zu betragen. Jedenfalls gelangt der Sand mit dieser jährlichen Intensität an die Bahnlinie der transkaspischen Eisenbahn und an das Ufer des Amu-darja. Auch dieser ist ein sehr schlammreicher Fluss, und auch er hat ein steiles rechtes Ufer dessen Steilwand durch die Strömung in 20 Jahren einen Kilometer nach NO. zurückweicht, während eine mehrere Kilometer breite Fläche auf dem linken Ufer in jedem Frühjahr weithin überschwemmt wird. Der von Norden herandrängende Sand der Kisilkum stürzt in das Wasser, wird eine Strecke stromabwärts getrieben und bei Hochwasser, vermischt mit dem sandigen Flusschlamm, auf dem linken Ufer wieder abgesetzt. *

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* *Gesetz der Wustenbildung*, p. 119.

Without reliable measurements such as those that have been taken in connection with the Trans-Caspian Railway, and in several similar places where cultivation and road-making are threatened by the invasion of the drift-sand, it is impossible to arrive at sure results.* I made indeed an attempt of this character in 1896, after the discovery of the ruins of the ancient town between Tavek-kel and the Kerija-darja, in that I made the following calculation: In the region of the buried city the prevailing winds come from the north-east and east, and are particularly violent in April and May. It is in these months that the greater number of the *kara-burans* or »black sandstorms» occur, which carry on their wings such vast quantities of sand and dust as to make day as black as night. In March and June come the *sarik-burans* or »yellow sandstorms», which, although less violent, nevertheless possess an enormous carrying capacity. — During the other months of the year the wind blows less frequently and with greater variableness. — On January 25th, with a tolerably strong south-west wind, I found that the crest of a sand-dune travelled 11.9 cm. to the north-east in the space of forty-five minutes. — The wind changed in the night, and the top of the dune then returned to the south-west, travelling 91 cm in 9 hours. Assuming that in every year there are on an average twenty-four days in which the wind blows with hurricane violence towards the south-west, and that on each such day it blows almost uninterruptedly, so that a sand-dune will travel six to seven feet (2 meters), it would travel altogether about 50 m. in the course of the year, and would therefore require a thousand years to reach the point at which the desert sand has now arrived in its journey towards the south. At the same time, it must be borne in mind, that I have assumed the greatest possible number of burans in the year, and hence have obtained a minimum estimate for the age of the city. — Then again the sand-dunes do not move directly south, but to the south-west, a circumstance which increases the probable age to some 1500 years. — Finally we have to take into account the less violent wind which blows in the opposite direction; which probably adds yet another five

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* Whilst travelling through Transcaspia by rail in 1890 I made certain hurried observations upon the methods adopted by the Russian railway engineers to protect their lines against the sand. These observations I recorded in my book (issued in Swedish) *Genom Khorasan och Turkestan* (vol. I, p. 230), where I wrote as follows: Unless special precautions were taken to arrest the sand, the dunes would soon climb upon the railway-line and bury the metals. Along the top of the dune-crest a thick hedge has been made of bundles of faggots placed upright in the sand, and by this means it is prevented from plunging down the steep slope, while the onward movement of the dune itself is also arrested, and it is compelled to halt where it is. Similar bundles of faggots and dry scrub are inserted along the outer edges of the railway line itself. Saksaul also has been planted for considerable distances alongside the line. The deep spreading roots of these plants hold the sand together in an effective way. The outer sides of the raised roadway along which the metals are placed are protected partly with a backing of clay, which prevents the underlying sand from being blown away by the wind, and partly with a network of plaited withes. In yet other places the roadway is protected by a hedge of dry faggots which overlap one another in the same way as slates do on the roof of a house. In this manner the engineers of the line have cleverly protected their work by means of such scanty materials as the locality itself affords.

Just as Marco Polo speaks of the great desert of Lop and its terrors, so also does Clavijo, the ambassador of Henry III of Castile to the court of Timur, in his journey across the Kara-kum (see the English translation in the Hakluyt Society's publications) in 1403 tell us, that his route lay across sandy deserts, where the wind whirled up the sand in clouds and hid the road, so that he frequently lost sight of it. These and similar notices are of course much too brief, to allow us to infer anything beyond this, that the Desert of Lop and the Desert of Kara-kum existed six hundred and thirty and five hundred years ago exactly as they exist to-day.

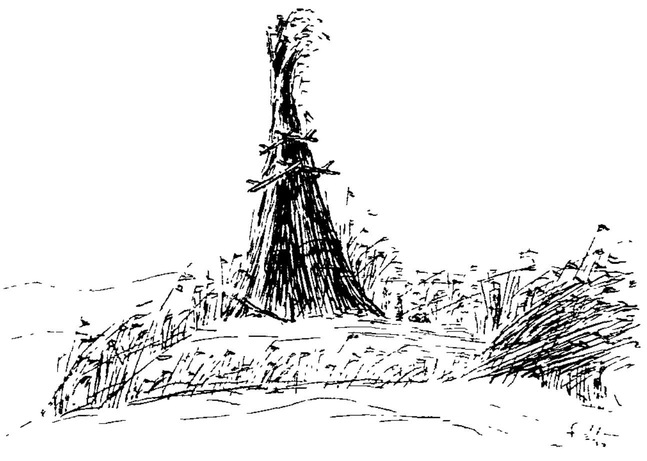

Fig. 183. THE MASAR OF ORDAN PADSCHAH.

hundred years to the age of the city.»*

Since that date these ruins have been visited by Dr M. A. Stein, who through the discovery of documents was enabled to state, that »the ruins were in reality abandoned only about the close of the eighth century of our era .** According to Stein's map the distance between the site of these ruins and the southern edge of the desert is 68 km. If then the town was abandoned 1100 years ago, the sand must have advanced meridionally 62 m. every year. But since the prevailing winds in that region blow from the north-east and east (even in January the form of the dunes gave evidence of the wind's blowing from those quarters), the rate at which the dunes advanced must really have been much greater, because their course will have been a diagonal one, not a course at right angles to the edge of the desert. I hasten however to observe, that these calculations are of doubtful value, especially as we do not know whether the ancient town, at the time when it flourished most, or at all events at the time when it was deserted, actually stood on the edge of the desert. My estimate however was based on the assumption that the desert-sand originated *after* the town was deserted. *One* fact is however established beyond all question by the existence of this sand-buried town, as well as by numerous legends,*** traditions, and historical data, as well as by other ruined sites along the southern border of the sandy desert that fills the basin of the Tarim, namely that as a matter of fact this desert is extending towards the south-west, and is now seriously threatening the narrow strip of cultivated ground which stretches along the northern foot of the Kwen-lun Mountains, and of which large portions have already been swallowed up by the irresistible advance of the all-engulfing dunes even during the brief period covered by local tradition.*

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* *Through Asia*, II. pp. 802—3.

** *Sand-buried Ruins of Khotan*, p. 324.

*** As to the different velocity and different dunes, depending upon their situation and their dimensions and the proportionality of the velocity to the mass of the dune, I may refer to Vol. I, p. 271 and 272, where I have laid down my opinion by help of some illustrations. I am glad to find exactly the same opinion expressed by Baschin in the following words: Der Grund dafur, dass die hohen Wanderdunen langsamer vorrucken als niedrige Dünen liegt einfach darin, dass unter sonst gleichen Bedingungen bei einer hohen Dune eine längere Zeit erforderlich ist, um an der Leeseite so viel Material anzuhaufen, dass eine merkliche Vorwartsbewegung des Dunenkamms eintritt als bei einer niedrigen. — Die Sandzufuhr durch den Wind ist ja bei hohen und niedrigen Dunen die gleiche, aber bei einer zehnmal höheren Düne muss die zehnfache Menge Sand auf der Leeseite abgelagert werden, um ein Vorrucken um den gleichen Betrag zu ermoglichen, sodass also die Geschwindigkeit der Vorwartsbewegung direkt proportional zu der Höhe der Dune ist. (Otto Baschin: »*Dunenstudien*, in *Zeitsch. d. Ges. f. Erdk. zu Berlin*. 1903. No. 6, p. 425.) Speaking of the same thing Rolland says: De fait, les grandes dunes du Sahara algérien marchent, dans leur ensemble, vers le Sud-Est, mais très lentement. Cette marche, presque nulle pour certaines chaînes, est d'autant plus sensible que le dépôt des sables dépend moins du relief sous-jacent et que les dunes emmagasinent moins d'eau, le relief étant fixe et l'eau contribuant aussi à fixer les dunes. Les exemples d'avancement rapide, pour des dunes de quelque importance, sont fort rares et tout à fait locaux . . . . Les grandes dunes marchent, elles s'élèvent, elles s'étendent. Leur progression n'est pas, en général du moins, notable dans la durée d'une génération: mais elle n'en est pas moins continué: d'où une modification graduelle de l'orographie du Sahara. In this connection I will quote also two of the very important general laws, in which Rolland is summing up the results of his dune-investigations: Le va-et-vient des sables sous l'action alternative des courants atmosphériques, se traduit finalement par un transport suivant la

With regard to the metamorphosis that the dunes undergo in their advance, that is, partly increasing, partly coalescing together, I share fully Walther's point of view, when he says: »Ich finde mich in Übereinstimmung mit von Middendorf, Sokolow, Muschketow, Bogdanowitsch und anderen Forschern, wenn ich betone: Die Bogendüne ist der normale Typus eines auf freier Fläche entstehenden Sandberges, sie muss überall entstehen, wo sich windgetriebener Sand anhäuft, and alle übrigen Dünenformen müssen prinzipiell von der Bogendüne abgeleitet werden. **

And with this agrees also Konschin's division of the Trans-Caspian deserts into 1) barkhan deserts, absolutely barren, and covered with crescentic dunes; 2) hummocky deserts, dotted with mounds held together by vegetation, which were dunes formerly; 3) deserts in which the dunes are arranged in rows, the arrangement

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direction de la résultante mécanique des vents, et cette direction est indiquée par les emplacements des grandes dunes par rapport aux régions qui les alimentent. Les grandes dunes ne sont pas, à proprement parler, mobiles, mais elles présentent une progression lente suivant la résultante mécanique des vents.» (Géol. du Sahara alg., p. 228).

* It should be easy to multiply the examples of cities and cultivated grounds, which, standing at the edge of a sand-desert, have been buried under the advancing sand-masses. Many travellers have given more or less graphic descriptions of such accidents. I will only quote two or three such examples. Loczy says: In der Nähe von An-si-fan, wo der Wind allem Anscheine nach mit dem Sande des Inundationsgebietes des Su-la-ho sein Spiel treibt, verursacht der Flugsand bereits mehr Unannehmlichkeiten. Die Stadtmauern sind von Sand umgeben und an der SO-lichen und SW-lichen Seite stecken dieselben ganzlich im Sande. Unweit des heutigen An-si-fan stossen wir in N-licher Richtung auf die gestampfte alte Mauer der verlassenen Stadt, innerhalb welcher sich nicht ein einziges Gebäude, sondern an Stelle dessen ein runder Teich befindet; auch diese Mauer wird rings herum von Sand umgeben. Solcher verlassener Städte gibt es ausserhalb der grossen Mauer mehrere. Kua-tschua ist ebenfalls eine verlassene Stadt, die anlässlich des letzten Aufstandes (1868—1872) von den Tunganen verstort wurde, doch mag ihre gänzliche Unbewohntheit und Verlassenheit wohl auch dem rings herum wehenden Sande zuzuschreiben sein . (*Die wiss. Ergebnisse der Reise des Grafen Béla Szechenyi*, I. p. 521). Mac Gregor says: »*Yuzd* is situated in what may rightly be termed an oasis. In all directions, immediately outside of the city and surrounding villages, there is a howling wilderness, where the sand seems to be gradually encroaching on the cultivation. I had always before found it rather difficult to realize such a thing as a city buried in sand and disappearing entirely. But places like *Yuzd* show the process clearly enough. At several points in the circumference of this town, the sand has reached quite up to the top of the wall and is now every day being blown into the interior. Of course the progress is slow, but it seems very sure (*Narrative of a Journey through the Province of Khorassan*, vol. I, p. 75).

And finally I may quote Bellew, who says: »The shrine of Ordam Padshah is itself buried in sand, and poles tufted with yak-tails mark the spot of the grave But the monastery, and some almshouses around are built on small, clear spaces on the plain, which appear here and there amongst the heaps of sand, and form as it were lanes running in the direction of the march of the sand-dunes. Some of the larger dunes, at a distance of three or four hundred yards off are directed obliquely upon the monastery, but as they seem to advance here at a very slow rate — twelve years having passed since the dune broke into the court of the tenement mentioned without having yet completely filled its area, which is only ten or twelve paces wide — the confident faith of the venerable Shekh who presides over it may prove justified. 'The blessed shrine has survived the vicissitudes of eight centuries', he said, in reply to our forebodings of the danger threatening its existence.« (*Kashmir and Kashgar*, p. 373) In *Pet. Mit.*, Ergh. No. 131, p. 232—33 I have made a comparison between Bellew's and my own observations regarding the dunes of Ordan Padschah, which I visited 22 years after Bellew.

** *Gesetz der Wustenbildung*, p. 125.

owing its origin in all probability to the crescentic dunes having coalesced and piled themselves one upon the other. Sokolow's statement: »Im Allgemeinen lässt sich behaupten, dass je entwickelter die Dünen sind und je breiter die von ihnen eingenommene Zone ist, um so mannigfaltiger sich ihre Gruppierung und um so geringer bei ihnen eine Neigung zur reihenweisen Anordnung zeigt, * is, generally speaking, sound. It applies, anyhow, to the western Takla-makan between the Jarkent-darja and the Kaschgar-darja, though on the other hand it does not hold good for the Desert of Tschertschen, which is not only broad and possesses dunes of gigantic size, but they are arranged in rows and chains of extraordinary regularity. Cholnoky, speaking of the tendency of the dunes to associate together, writes as follows: »Naturlich wachsen die Dünen fortwährend, die rückwärtigen holen die vorderen ein, begraben dieselben, nachdem der Wind die hinteren stärker angreift, als die vorderen, ihre Grösse wächst stetig, da der bis zum feuchten Teil ausgewehte Sand zu trocknen beginnt und somit neue Sandmengen an der Dünenbildung teilnehmen, und, wenn der Wind anhaltend und stark ist, entstehen alsbald auf dem Ursprungsorte des Sandes, vertikal auf die Windrichtung, Wälle von ziemlich gleichmässigen Dimensionen.»**

Finally I will add just one more quotation from Sokolow: »Ziemlich selten finden sich die Bogendünen vereinzelt; viel häufiger verschmelzen mehrere, mit ihren Seiten an einander stossende, zu einer einzigen von zusammengesetzter Form, welche auf mehrere sich kreuzende Bogen von verschiedener Wölbung und verschiedener Grösse zurückzuführen ist. — Manchmal ergiebt sich in Folge derartiger wiederholter Verschmelzungen eine so verwickelte Form, dass nur unter grossem Müheaufwand und auch nur bei gewisser Übung die Gestalten der ursprünglichen einzelnen Bestandteile wieder hergestellt werden können.»***

Amongst coast-dunes small isolated lakes and lagoons are by no means rare. On the other hand marginal lakes like those of the lower Tarim would appear to be a very unusual, not to say an unique, phenomenon, and it is a peculiar coincidence, that all the conditions essential for their origination — depressions, masses of sand, water, and constant winds — coexist in one and the same patch of earth. There are hollows between dunes in all parts of the world, but hollows that exhibit such a remarkable development and regularity as the bajir-depressions of the Desert of Tschertschen will hardly be found anywhere else than there. Yet amongst the materials that Sokolow has subjected to examination there occur phenomena which are at all events cognate with the bajir-depressions I have described, and which strengthen in me the conviction that the explanations as to the origin of those depressions, which I have given in the first volume, are correct. But in order to substantiate this view, I must cite yet one or two other passages from Sokolow's excellent book. »Die zwischen den Stranddünen auftretenden Vertiefungen stellen entweder Längs- bezw. Querthäler oder geschlossene Mulden dar. Diese Vertiefungen sind entweder durch den Wind ausgehöhlt, demnach Windmulden, oder einfach vom Sande nicht verschüttete Teile der Bodenfläche, auf welche die Dünen gewandert sind, also Vertiefungen früherer Wasserbehälter, Lagunen, Flussbette, u. dgl. m. Die Windmulde vertieft sich entweder nur in den angewehten Sand bis zum festen Grunde hin, oder, wenn dieser selbst eine sandige Bildung ist, noch viel tiefer . . . Die Gestalt der Furchen, welche nichts Anderes sind, als vom Flugsande freigelassene Dünenzwischenräume, steht in voller Abhängigkeit von der Gestalt und der Verteilung der sie umgebenden Dünen. Wegen der gewöhnlich reihenweisen Gruppierung der Stranddünen nehmen auch die Furchen hier einen Längsthälern entsprechenden Verlauf, wogegen die vom Winde ausgeblasenen Furchen, welche auch in der Richtung des Windes zu wachsen pflegen und sich miteinander vereinigen, Querthäler bilden . . . Mit der Zeit kann in den eben besprochenen Furchen ein kleiner See oder Sumpf entstehen, sei es dadurch, dass eine Dünenkette das von kleinen Bächen zugeführte Wasser aufhält, oder dass sich in ihnen als tiefer liegenden Stellen atmosphärisches Wasser ansammelt . . .: solche Wasserbehälter sind in Dünengebieten nicht selten anzutreffen. *

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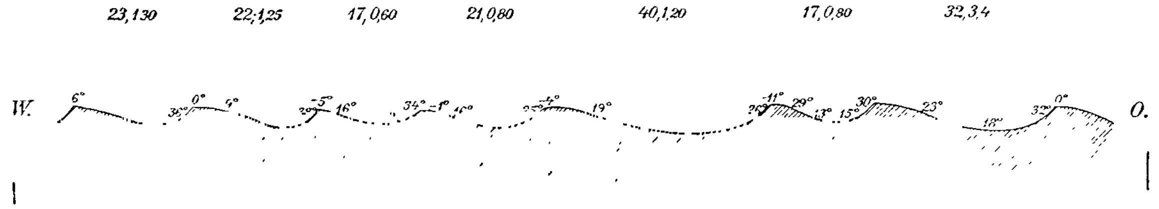
* *Die Dunen*, p. 98.

** E. von Cholnoky. *Die Bewegungsgesetze des Flugsandes*, in *Foldtani Kozlony*, vol. XXXII., p. 130.

*** *Die Dunen*, p. 89.



RELATION BETWEEN LENGTH AND HEIGHT, AND ANGLES OF DUNES IN THE WESTERN TAKLA-MAKAN DESERT.

At Alëschki there exists something that reminds us of the marginal lakes of the Tarim: »In Folge der geringen Höhe der ganzen Gegend über dem Dnjepr-Niveau, befindet sich das Grundwasser überhaupt nicht weit unter der Oberfläche, und daher bleibt der Sand auf dem Boden einiger Mulden während des ganzen Sommers feucht. Ausserdem sind inmitten dieser Dünen kleinere Seen sehr zahlreich. Einige von ihnen sind mehrere Kilometer lang. Diese Seen sind meist zu Gruppen vereinigt oder bilden Reihen; seltener liegen sie vereinzelt. **

The depressions in which these small lakes lie have of course been formed by erosion, whether of the wind or of water: but although they do undoubtedly admit of being compared with the marginal lakes of the Tarim, they will never, for reasons that are fairly obvious, be able to attain to the same degrees of regularity and size that those lakes exhibit. The cross-thresholds that separate the bajirs of the Desert of Tschertschen are perhaps in some respects akin to the type of dune which Cholnoky calls *garmada*.

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* *Die Dunen*, pp. 101. 103.
** *Die Dunen*, p. 241.

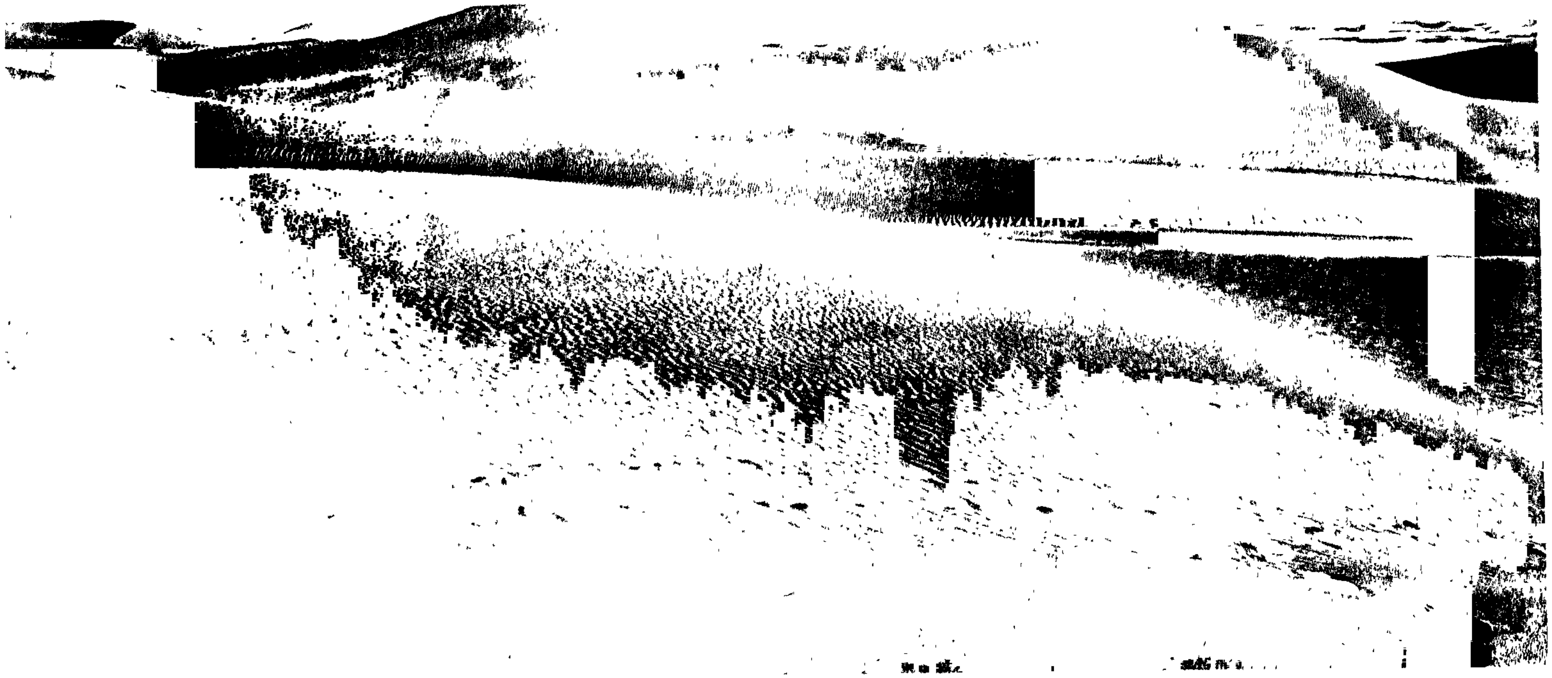
# CHAPTER XXVIII.

## RIPPLE-MARKS; ORIGIN OF DUNES; WAVE-MOVEMENTS.

The question of the relation which the so-called »ripple-marks» bear to the fully developed dune appears to be still subject of discussion. The point to be determined is how far the ripple-marks are genetically connected with the dune, that is to say how far they constitute a species of embryonic dune, out of which the fully developed dune is in process of time evolved, or whether they are simply superficial phenomena that are complete in themselves and unable to develop into any »higher» form of sand-wave. Strange to say, two such accurate investigators as Cornish and Cholnoky, both of whom have derived their experience and the *data* for their reasonings direct from nature, are in this matter diametrically opposed to one another. Cornish advocates the former view, Cholnoky the latter. Cornish arrives at the following amongst other conclusions:

»In the case of wind-formed ripples I concluded, from the fact that the wave-length increased steadily with the time during which the wind blew, that the sand-grains were the source of those regular undulations of the air the existence of which is attested by the uniformity of the ripple-pattern.» This conclusion Cornish confirmed by experiment in a sand-blast works: »In a few minutes the surface became rippled, and the ripples grew in height, in wave-length, and in regularity, under the constant blast»; and he enunciates the law that underlies the process in the following terms: »The rippling of sand takes place when the eddy in the lee of the larger grains is of sufficient strength to lift the smaller.» Then he goes on: »The ridges of wind-formed ripples advance almost entirely by the rolling of the larger grains of the top layer over the crest. The motion is slow, for the eddy opposes the wind; one foot per hour would be pretty good travelling. The rate of advance of a ridge diminishes with increase of amplitude, for the advance is by rolling of the top layer, and the number of layers of sand-grains is proportional to the amplitude. A growing ridge consequently lags, thus increasing its distance from the next leeward ridge. Again, the increase of height of the windward ridge is accompanied by increase of strength of the eddy and by increase of length of the air-billow which tops the eddy, so that the sand shower is thrown further to leeward. This is a part of the mechanism by which the ratio of amplitude to wave-length is kept constant. The remaining part of the mechanism

Pl. 45.



Ljustr. A. B. Lagrelius & Westphal.

DUNES IN MIDDLE OF DESERT OF GOBI, 30TH JANUARY 1901.

is the quicker travel of lower windward ridges, which results in their catching up and becoming merged in the ridges to leeward. — The forms of dunes, and of groups of dunes, have a greater variety than those of ripples, and are often more complicated, for a dune may register the impress of many changing winds. Another important difference between the small-scale and large-scale phenomena is that in the latter the heterogeneity of wind is much more important. In this term I include both intermittence and the want of uniformity of the cross-section of a sheet of wind. Unlike wind-ripples, dunes do not necessarily owe their origin to the resistance of the sand-grains. In the case of transverse dunes in deep deserts there appears, however, to be actual continuity between ripple and dune, the latter being (on this supposition) old ripples. — Rippling action plays a part in the shaping of every dune.»*

Cholnoky's view is however the direct opposite of this. He says: »Schon die feine Rippelmarkung erinnert lebhaft an die auf der Oberfläche des Wassers entstehenden Kreiselungen; die wunderbare Gleichmässigkeit der Rippelmarken lässt aber diesen Vergleich ziemlich oberflächlich erscheinen. Spätere Erwägungen werden es klarlegen, dass diese Erscheinungen mit dem Wellenschlag durchaus nicht identisch sind und die Ähnlichkeit eine nur ganz äusserliche, oberflächliche ist. Wir werden sehen, welchem Irrtum Vaughan Cornish verfiel, als er dieselben als Sandwellen (sand-waves) bezeichnete, und die grossen Sandhügel als vergrösserte Ausgabe der Rippelmarken betrachtet.»

Then he goes on to say, that Baschin, building upon Helmholtz's wave-theory, arrives at the same conclusion as Cornish, namely, that sand-dunes are identical with waves. Cholnoky sets forth his own view in the following words: »Die Dünen unterscheiden sich aber wesentlich nicht nur insoferne als dies Baschin erwähnt, sondern gerade im wichtigsten, ich möchte sagen, im Definirungspunkte, von der Wellenbewegung. Die Wellenbewegung ist im wissenschaftlichen Sinne eine periodische, eine Orbitalbewegung; Welle ist aber ein solches Stück des in der periodischen Bewegung befindlichen Mediums, das eine vollständige Reihe der in sämtlichen Phasen befindlichen Medienelemente enthält. Die Bewegung des Sandes der Dünen ist eine fortschreitende Bewegung, die Düne selbst eine fortschreitende Masse, die während ihrer Wanderung durch den Wind eine eigenartige Form annimmt. Die Bewegung der Sandkörner hat zwar Perioden, nachdem das Sandkorn an der sanften Böschung der Düne hinaufwandert, sodann auf der Steilböschung hinabrutscht und dann solange unbeweglich bleibt, bis die Düne mit einer ihrer eigenen Breite gleichen Strecke vorwärts gewandert ist. Alsdann beginnt das Sandkorn wieder seine Bewegung. Während aber die Form der Wellenoberflächen von der Orbitalbewegung der an der Wellenbewegung teilnehmenden Molekülen verursacht wird, entsteht die Form der Düne nicht infolge der Bewegungsperiode der Sandkörner, sondern gerade umgekehrt, die Form der Sanddüne ruft die Periodicität in der Vorwärtsbewegung des Sandkornes hervor. Es fehlt sonach dem Charakter der Sanddüne die definirende Eigenschaft der Wellenbewegung; infolge dessen ist die Düne mit einer Welle nicht identisch . . . Ich hebe besonders hervor, dass die Dünenbildung ein von der Entstehung der Rippelmarken sich wesentlich unterscheidender Vorgang ist . . . Aus Rippelmarken wird nie eine Düne, da die Dimensionen ersterer festgesetzt sind. Übergänge zwischen den beiden sind nicht vorhanden.» *

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* *On the Formation of Sand-dunes*, in *Geographical Journal*, March 1897.
See also Cornish: *On Desert Sand-dunes Bordering the Nile Delta*, in *Geographical Journal*, January 1900, a paper accompanied by admirable illustrations.

Cholnoky emphasises the following differences between waves and dunes: »1. Bei der Wellenbewegung befinden sich sämtliche Punkte des Mediums in Bewegung. Bei der Wanderung der Düne bewegen sich nur die unmittelbar, dem Wind ausgesetzten Teilchen. 2. Bereits Baschin erwähnt, dass der Wellenschlag des Wassers, nachdem sich der Wind gelegt hat, weiter dauert; die Sanddune bewegt sich dann nicht mehr. 3. Die Dimensionen der Welle hängen so sehr von der Geschwindigkeit des Windes ab, dass ein Wind bestimmter Grösse nur eine bestimmt grosse, vollständig ausgebildete Welle hervorrufen kann, eine grössere aber nicht. Die Grösse der Sanddüne hängt von der zu Gebote stehenden Menge des Sandes und der in dieser Hinsicht effektuirten Arbeitsmenge des Windes ab. Ein wie immer kleiner Wind ist im Stande. eine Düne von beliebiger Grösse zu Stande zu bringen, wenn derselbe genügend lange Zeit anhält und eine hinreichende Menge Sandes zur Verfügung steht.»

Thus, while Cornish considers that the ripple-marks are able to grow into dunes, Cholnoky holds that dunes never can grow up out of ripple-marks, and consequently that there never can be any intermediate forms between the two. In this question I make no pretensions to pose as an authority, for, as I have already said, my investigations are far from being sufficient; but in the light of the experience which I gathered in the desert — a desert which more than any other does admit of being compared with the ocean, and consequently its dunes of being compared with the waves of the ocean — I am bound to confess that my conception approximates nearer to Cornish's view than to Cholnoky's.

Most geological hand-books attribute the tendency of the drift-sand to form dunes to the presence of obstacles in its path. Penck, for instance, says: »Die Bildung der Dünen erfolgt nach denselben Regeln wie die der Schneewehen. Sie knüpfen sich an eine Verlangsamung der Windbewegung durch irgend welches Hindernis . . . Das Hindernis kann gelegentlich fast unmerklich sein . . . in der Regel besteht es in niedrigem Gesträuche oder Gebüsche.»**

Even Rolland, who has studied some of the great dunes of the Sahara, is of opinion that the formation of dunes, or rather the distribution of dunes, is dependent upon the configuration and nature of the soil: ›En petit, on voit journellement au désert, derrière les touffes parsemant la surface çà et là, le vent déposer des tas de sable, la plupart insignificants et éphémères. Certains arbustes, tels que les tamarins, ont la propriété de fixer les sables qui garnissent ainsi leurs pieds, en les agglomérant avec leurs feuilles; ils deviennent alors autant de barrières qui arrêtent d'autres sables, s'augmentent, s'élèvent et, à la longue, peuvent atteindre jusqu'à une trentaine de mètres. Ailleurs on remarque parfois que la simple humidité du sol peut suffire pour qu'il s'y forme des dunes: les sables sont allors happés au passage par l'eau, puis retenus par la capillarité et, en fin de compte, fixés sur place. Telle ou telle zone, offrant quelque végétation et quelque humidité, arrivera ainsi à s'ensabler graduellement; mais, qu'elle occupe un bas-fond ou une vallée — ce qui sera généralement le cas il sera encore vrai de dire ici que l'emplacement des dunes résulte de la configuration et de la nature du sol . . . . . . Actuellement ces reliefs sont le plus souvent masqués par d'énormes accumulations de sables, et même quand ils se montrent à découvert, ils peuvent, au milieu des grandes dunes, échapper à l'œil du voyageur. Mais il est bien certain que les regions ainsi ensablées ont leur orographie et leur hydrographie souterraines, qui sont entervenues dans la répartition des sables superposés. *

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* *Die Bewegungsgesetze des Flugsandes* in *Foldtani Kozlony*, vol. XXXII, pp. 106 a ff.
** *Morphologie*, I. p. 251.

Some authors go however too far in this direction, in that they almost seem to deny the origination of dunes in the absence of local impediments. For instance: »Wäre das Land ganz eben, so würde sich der aufgetriebene Sand gleichmässig darüber verteilen. Findet er aber ein Hindernis, wie einen in den Boden eingeschlagenen Pfahl, so wird der Wind vor und hinter dem Pfahl geschwächt und lässt dort einen Teil des mitgeschleppten Sandes fallen.»** Neumayr lays down the same views even more plainly in the following sentences: »Würde der Sand über eine ganz vollkommene Ebene getrieben, in der ihm keinerlei Hindernis entgegensteht, so würde er sich gleichmässig ausbreiten, wo aber ein solches Hindernis vorhanden ist, da fällt er in grösserer Menge nieder; es genügt, eine Reihe von Pflöcken senkrecht zur Windrichtung an einer Küstenstrecke einzuschlagen, an welcher der Sand treibt, um die Bildung einer Düne künstlich zu bewirken . . . In der Natur bilden Steine, Pflanzenwuchs und ähnliche Körper das Hindernis, welches den ersten Anstoss zur Dünenbildung gibt.»***

Exactly the same opinion we find expresed in the following sentence by Prof. S. Günther: »Wäre die Strandfläche absolut glatt, so würde sie sich mit einer gleichmässig dicken Sanddecke überziehen; sowie sich aber irgend eine Unregelmässigkeit des Bodens dem fortgetriebenen Sande entgegenstellt, ist ein Ansatz zur Dünenbildung gegeben.»†

But O. Baschin, basing his arguments upon Helmholtz's law, says, that waves must always be set up on the contact surfaces of two fluids or two gases of different specific gravity and different velocity, if they are to preserve themselves in stable equilibrium.†† Hence Supan says justly: »Stauende Hindernisse sind also keine not-

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* *Géol. du Sahara Alg.*, p. 221.

** Arrhenius, *Kosmische Physik*, II. p. 768.

*** *Erdgeschichte*, I. p. 527.

† *Handbuch der Geophysik*, vol. II, p. 616.

†† By studying the dunes simply and alone in the field, I have arrived at exactly the same conclusion as Baschin, who gives the following clear and interesting explanation of the phenomenon: »Die wirkliche Ursache, welche auf einer ebenen, lockeren Sandoberfläche regelmässige, wellenähnliche Formen erzeugt und somit die Grundlage für die Regelmässigkeit weiterer Sandanhäufungen schafft, ist vielmehr meiner Meinung nach die Tendenz zur Bildung einer Helmholtz'schen Wellenfläche. — Weht nahmlich der Wind über eine ebene Fläche, so ist die Tendenz vorhanden, diese Oberfläche in Wellenform zu legen. Haben wir es nun mit einer starren Fläche zu thun, die dieser Tendenz Widerstand leistet, z. B. einem freien, mit Asphaltpflaster bedeckten Platz, so wird diese Tendenz zur Wellenbildung sich nur in periodischen Änderungen des Luftdruches bemerkbar machen, die natürlich nicht sichtbar sind. Diese Luftdruckänderungen werden aber sofort sichtbar, wenn der Platz mit feinem Sand bestreut wird, indem dieser sich auf den Linien geringerer Druckes, die den Wellenbergen entsprechen, anhäuft

wendige Vorbedingung der Dünenbildung, wie man früher angenommen hat, aber jedenfalls befördern sie dieselbe. Und es gibt deren überall: Muschelhaufen, Baumstümpfe, Sträucher u. s. w., und kein Hindernis is zu klein, denn der gestaute Sand macht es selbst von Tag zu Tag grösser.»[*]

If, disregarding formulæ and theories, we go to nature herself, the impression conveyed is that the conception last quoted is the only right one. For instance, in the Desert of Tschertschen and the west of the Desert of Lop the surface is inconceivably level, and there exist no irregularities or obstacles to cause the sand to accumulate, and yet we find there dunes of unparalleled amplitude and regularity of formation. There then they do not owe their origin to any peculiar properties of the surface. If Neumayr's view were correct, we should expect to find in the Desert of Tschertschen a flat, evenly disposed sand-field without dunes. For my own part, I believe that, if the masses of sand now in the Desert of Tschertschen were to be spread out perfectly evenly over the entire desert in a layer some 30 m. thick, the sand would after a certain lapse of time be rearranged by the wind in dune-accumulations precisely similar to those that now exist. If such an absurd eventuality could be at all contemplated, as that the wind should for the space of one, or even two centuries blow constantly from the north, the relief of the sand would change conformably; but if it were then to be changed back to its usual east-north-east direction, the desert would again resume its old relief — assuming of course that no disturbing element were introduced through the agency of secondary factors, such as the checking of the supply of sand by a new position taken up by the Tarim. I mean, that the relief and orientation of the masses of sand in the Desert of Tschertschen are prescribed by absolute and incorruptible laws of the wind, and that, so long as the wind relations remain what they are, those masses of sand could not arrange themselves in any other way. And I believe, further, that this intimate connection between the wind and the relief of the sand is every bit as subject to law as are Chladni's »sonorous figures», which are exemplified by means of a thin layer of sand on an elastic plate, the sand returning with the same minute fidelity to a certain part of the plate every time the layer is shaken.

The formation of dunes is of course likewise occasioned by obstacles, for example vegetation; but nobody, I suppose, will maintain, that the regular dune-accumulations of the Desert of Tschertschen have grown up out of dunes which have originated in that way, or that, did such obstacles not exist farther east in the desert, the sand-masses of the Desert of Tschertschen would have arranged themselves in any other way than that they now exhibit. Sokolow says truly: »Wenn sich hinter dem Strande eine ebene Fläche befindet, welche frei ist von windhemmenden oder schwächenden Gegenständen, so lagert sich der vom Winde getriebene Sand als gleichmässige Schicht ab und bildet ein Sandfeld, dessen einzigen

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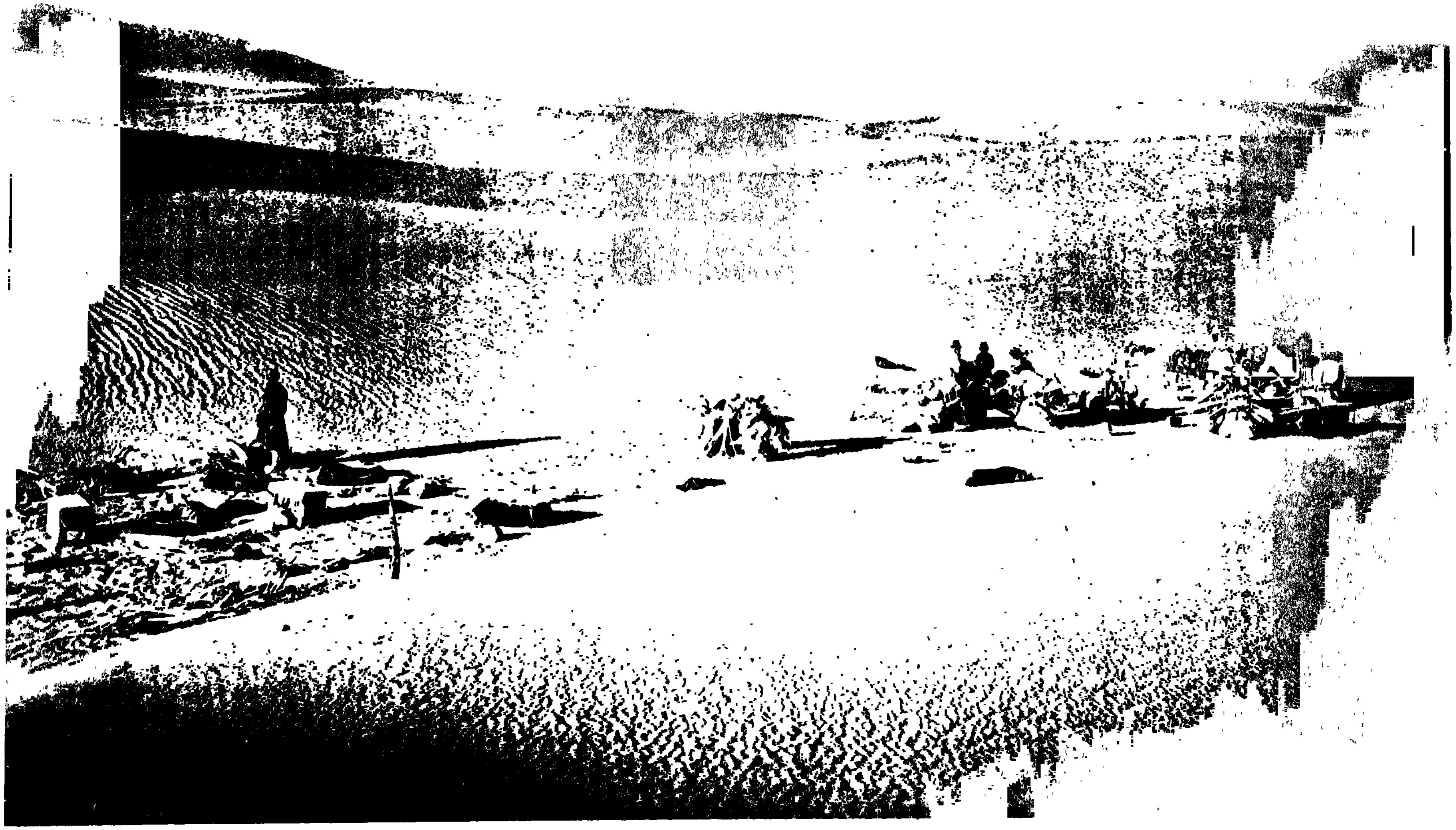
wahrend er an den Linien stärkeren Druckes, die den Wellenthälern entsprechen, fortgeblasen wird .... Dass die Dunen keine zufälligen Sandanhäufungen, sondern wirkliche Wellen sind, ist von manchen Beobachtern gleichsam instinktiv geahnt worden .... (*Die Entstehung wellenähnlicher Oberflachenformen, ein Beitrag zur Kymatologie* by Otto Baschin, in *Zeitschrift der Gesellschaft fur Erdkunde zu Berlin*, vol. XXXIV. p. 419.

[*] *Grundzuge der physischen Erdkunde*, p. 505.

Pl. 46.



*Ljustr. A. B. Lagrelius & Westphal,*

CAMP CXXXV, IN MIDDLE OF SANDY DESERT, JAN. 30TH 1901.

Unebenheiten in den parallel verlaufenden flachen Sandwellen bestehen . . . In der überwiegenden Mehrzahl der Fälle bietet die Gegend von der Küste ins Innere des Landes hinein solche vollkommen glatte Flächen jedoch nicht dar; sie ist mehr oder weniger uneben.»*

But so far as I am able to follow it, this statement really amounts to a proof that dunes do gradually grow up from an embryonic or rudimentary stage, such as they would have at the windward edge of a sand-field. That fully-formed dunes are not to be looked for at that edge is an implicate of the very nature of the case, for the material for them is of course locally wanting. The level surfaces decrease also towards the interior of the sand-field, and finally they cease altogether.

This leads us to the consideration of the transformations that dunes undergo in the course of their advance and development. Walther, speaking of the formation of the dunes beside the Trans-Caspian Railway, says: »Der feste, graue Thonboden wird hier überlagert von lockerem, gelbem Flugsand; das Sandgebiet endet aber nicht etwa in Gestalt eines einheitlichen Walles, sondern löst sich an seinem Rande in einzelne Sandhaufen auf, welche nebeneinander die verschiedensten Stadien der Dünenbildung beobachten lassen. Der Beginn der Dünenbildung ist ein flacher Sandhaufen von beliebiger Gestalt. Die Entstehung dieses Sandhaufens kann veranlasst werden durch unbedeutende Rauhigkeiten des Bodens, kleine Steinchen oder Grashalme, vielleicht sogar durch die wellenförmige Bewegung der Luftstösse. Jedenfalls ist seine Gestalt sehr wechselnd und regellos.»**

To the statement, that the flat sand-heaps may assume any and every shape, he might also safely have added, that they may also be as small as you please; in fact this conclusion is implicit in the statement, that adjacent sand-heaps may present themselves in all stages of dune-formation. Walther here calls attention also to the fact, that the wave-like succession of the gusts of wind is quite sufficient to account for the initial origination of the little sand-accumulations.

With regard to the Kara-kum Walther says further: »Am Rand des Sandgebietes herrschen die Einzelbarchane vor. Je mehr man aber in die innere Region der Sandwüste eindringt, desto zahlreicher werden die reihenförmig verschmolzenen Dünenkämme. Zwei, sechs, zehn Bogendünen haben sich seitlich aneinandergelegt, nur bei gewisser schräger Beleuchtung erkennt man an dem wellenförmig gebuchteten Dünenkamm die Form der einzelnen Barchane wieder. Der Vorgang dieser Verschmelzung würde ohne Zweifel auch in der Kara-kum viel weiter vorgeschritten sein, wenn nicht in jedem Jahre zwei Windrichtungen einander ablösten . . . Dadurch werden in jedem Jahre die gebildeten Barchanreihen wieder zerschnitten und in Einzeldünen aufgelöst, und es kann nicht zur Bildung langgestreckter Dünenkämme kommen.»***

These observations are in complete agreement with those I made in the Desert of Tschertschen. Out of the recently mentioned small flat sand-heaps there are successively developed, by degrees and after several intermediate fluctuating stadia, first single barkhans, then lines and chains of coalescing dunes, which again grow and increase in the process of time.

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* *Die Dunen*, p. 162.
** *Gesetz der Dunenbildung*, p. 122.
*** *Op. cit.*, p. 126.

Sokolow, after comparing together the ripplings of lacustrine and marine waves and the ripple-marks of the dunes, and pointing out their dissimilarities, goes on to say, speaking of the last-named: »Sie wachsen ununterbrochen in die Höhe, indem sie die auf der Oberfläche bewegten Körner aufhalten, und wandern zugleich, weil der Sand von der Luvseite beständig auf die Leeseite hinübergeweht wird.» Sokolow does thus appear to contemplate the existence of forms intermediate between ripple-marks and individual dunes.

Cholnoky emphasises with good reason the difference between water-waves and sand-waves, and indeed it would be futile to expect anything else in two media that present such diverse properties of aggregation as these do. Owing to the cohesion of the aqueous molecules shocks and impulses in the mass of water are propagated in waves; and if the force is not maintained, after a while the wave-movements die away. Particles of sand on the other hand are free, isolated bodies, separated from one another by layers of air, and a thrust or other external application of force takes effect only at the point at which it is applied, without being transmitted sideways. A sea which has been agitated by a persistent storm becomes as smooth as a mirror some time after the storm has subsided. Sand-waves on the contrary which have been piled up by the wind retain their positions even after the wind has fallen. The only laws they are subject to are those of gravity, and in consequence of their aggregational properties, they are unable to alter their positions, as water does, until some fresh external force is applied to them. Their form and shape are determined by the wind, and to this must be added, further, the property which the sand possesses of disposing itself on the leeward side at the steepest angle actually possible to it, an angle which I found in several instances to be equal to 32° to 33°. (Sokolow gives 29°—32° as the limit-value in the case of the dunes beside the Gulf of Finland and the Gulf of Riga.)

And yet, notwithstanding these great and perfectly natural differences, the formation of dunes and the formation of waves are identically the same phenomena. Drift-sand is, like water, a medium that readily responds to the influence of the wind, and obeys all its caprices. But in the case of the particles of sand the great amount of friction set up between them has the inevitable result of making all their movements incomparably slower, and that altogether apart from their inability to propagate movement once the wind has ceased. Unlike though these two media are to one another, yet, when acted upon by identically the same force, namely wind, they present phenomena of motion which resemble one another, at all events in certain respects. Several of the points of difference between waves and dunes, upon which Cholnoky dwells, nevertheless present, according to my conception, certain features of resemblance, and where these features of resemblance are wanting the cause is to be sought in the aggregational properties, and consequently the absence is due to a quite natural cause. For instance, Cholnoky calls attention to the fact that, whereas in wave-movement every point of the medium is in motion, in dune-movement those points only are in motion that are affected by the wind. If the movement of an aqueous wave makes itself perceptible to a depth equal to

350 times the altitude of the wave, in the case of sand it is the height of the wave itself that determines the maximum depth to which the movement penetrates. This may indeed be observed with the naked eye in the smallest variety of sand-waves (namely ripple-marks) when the wind blows strongly, for the ripple-marks then move onwards in the direction of the wind. The same thing is true of dunes and dune-accumulations, the only difference being that the periodic interval increases with the mass. Whereas the movement of the aqueous wave is orbital, all its molecules partaking simultaneously in the movement, the movement of the dune is a rolling or revolving mass-movement, in which each particle of sand participates in its due turn according to its position in the mass; but before the periodic interval is completed, every individual particle that constitutes the mass has had its turn in the revolution, just as every molecule of the water participates in the orbital movement of the aqueous wave. With regard to the depth to which movement is perceptible, I would observe, that this is greater in sand than in the sea or deep lakes. In the Lake of Geneva the greatest depth to which ripple-marks have been observed is, according to Forel, 9 m. below high-water level. In the great oceans the depth to which wave-movement is propagated has theoretically no limit, although the amplitude decreases rapidly; but practically the depth to which such movement is observable cannot be especially great. In sand there is but one amplitude; for the entire mass, no matter how high it may be, takes part in the periodic movement — assuming that the circumstances are the same as those which obtain in the Desert of Tschertschen, where the depth of the wave-movement is equivalent to the general mass of the medium, that is to say it goes down to the clay foundation. In the case of sand the period is inconceivably longer, but the height of the wave is very much greater, than in the case of water; this again being dependent upon the aggregational properties. The waves of the sea reach an altitude of 15 m.; sand-waves, to speak only of those that are affected by constant winds, ascend ten times as high, and it is only such that can be compared with ordinary oceanic waves. The differences in the movement of sand and the movement of water are great, because there exist extremely great differences in the aggregational properties of the two.* Let us take a substance the aggregational properties of which

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* With regard to the difference between water-waves and sand-waves O. Baschin makes the following remarks: ›Ein gewaltiger Unterschied gegenuber den Wasserwellen bleibt naturlich bestehen, das ist derjenige, der seine Ursache in der Verschiedenheit des Materials hat. So leicht beweglich auch der feine Sandstaub sein mag, so hat er doch lange nicht die gleiche leichte Beweglichkeit wie eine Flussigkeit, und dies hat zur Folge, dass nach dem Aufhoren der wirkenden Ursache die in Wellenform gelegte Sandoberflache sich nicht wieder glattet, wie das Wasser, sondern dass die einmal gebildeten Unebenheiten bestehen bleiben und nun allerdings als Hindernisse wirken und zur Wirbelbildung und dadurch verursachter weiterer Sandanhaufung fuhren konnen. Eine weitere Wirkung dieser Verschiedenheit des Materials aber besteht darin, dass die Sandwellen sich, so lange sie noch klein sind, mit dem Winde ziemlich schnell vorwarts bewegen, ähnlich wie Wasserwellen, dass dies aber aufhort, sobald sie eine betrachtliche Grosse erreicht haben. Der Grund dieses eigentumlichen Verhaltens ist darin zu suchen, dass die Fortbewegung der Sandwellen einen Massentransport bedeutet, der nur so lange mit einiger Geschwindigkeit vor sich gehen kann, als es sich um unbeträchtliche Massen handelt, während bei den Wasserwellen die einzelnen Wasserteilchen keinen translatorischen Bewegungen unterliegen, sondern nur Orbitalbewegungen an Ort und Stelle ausfuhren. Wahrend bei ganz kleinen Sandrippeln noch beinahe die ganze Sandwelle in ihrer Gesamtheit sich vorwärts bewegt, besteht die langsame Vorwartsbewegung der Dunen darin, dass die vom Wind vorwarts getriebenen Sandkorner den sanften der Luvseite zugewendeten Abhang bis zur Kammlinie hinaufgetrieben werden, um an der steilen Leeseite

are something between these two, say molten lava; then, in respect of movement also this will come intermediate between water and sand. Lava flowing down a mountain-side does so with a rolling motion, like that of the sand in a moving dune, and it would also exhibit the same kind of motion if the wind were powerful enough to move it upon level ground. The difference between the wave-movement of viscous fluid and the wave-movement of a mass of sand will therefore be less than the difference between the wave-movement of sand and the wave-movement of water. Driving snow accumulates in dune-like drifts, which in several respects differ from dunes: the higher the former are the more they become compressed by their own weight, until their lower layers grow so compact that all possibility of movement ceases. By this I mean that the same force, the wind, when acting upon different substances that in turn react upon it, ought to give rise to the same kind of wave-movement, although the manner in which this is produced may be more or less different in consequence of the different properties possessed by the several substances.

Cholnoky goes too far when he asserts, that sand-waves and oceanic waves are in no wise identical phenomena, and that the resemblances between them are entirely external and superficial. Has not Heim demonstrated that there exist an entire series of resemblances between a glacier and a river?* And the conclusion he comes to is this: »Soweit bis jetzt unsere Erkenntnis reicht, stimmen alle Gesetze der Gletscherbewegung mit denjenigen einer flüssigen Masse überein. Bei einer absoluten Flüssigkeit ist der innere Widerstand der Teilchen gegen Verschiebung unendlich klein im Vergleich zu der Schwere derselben . . . Das Gletschereis ist in seinem Fliessen etwa 80 bis 100 Millionen mal träger als Wasser.»

Here the motive force is of course different, namely gravity, while the arresting force is principally friction. But notwithstanding that the two substances we are now considering, water and ice, possess such diverse properties of aggregation, we nevertheless have in both the same phenomena of movement, the reason being that both are set in motion by the same force and under the same circumstances. It should not therefore be too bold a thing to say, that waves and dunes are identical phenomena, especially as sand, despite the fact that each individual particle is a solid body, when taken in the mass becomes rather a fluid substance, — a property which we find put to practical use in the time-glass. Sand in the mass possesses no inherent cohesion; friction alone is present. With regard to wave-movement, water and sand are more closely akin than are water and ice. A cascade of sand would present greater resemblance to a waterfall than a cascade of ice, i. e. a glacier, would, the velocity of the last-named being infinitesimally slow as compared with the velocity of water and of sand. The greatest difference between the movement phenomena of a glacier and the movement phenomena of a river lies in the excessive slowness of the former. The same difference obtains between sand-waves and

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herabzufallen, wonach durch Wirbel-bildung an der Leeseite einige Komplikationen kommen. — Durch dieser Unterschied in der Art der Fortbewegung von Wasser- und Sandwellen erklaren sich auch die meisten anderen Unterschiede zwischen beiden, z. B. die von der Form der Wasserwelle verschiedene Form der Dune mit ihrem charakteristischen Unterschied zwischen Luv- und Leeseite, die Schrichtung der Dunen und vieles andere. (*Zeitsch.* d. *Ges. f. Erdk. zu Berlin*,. vol. XXXIV. p. 421).

* *Handbuch der Gletscherkunde*, pp. 185 ff.

water-waves. If we were to imagine dune-waves which, while still retaining precisely the same properties that they actually do possess, were to be impelled by the wind at a velocity equal to that of the waves of the ocean, and supposing that the drifting sand did not hide the prospect of this imaginary sandy ocean, then the resemblance between their movement and the movement of the on-rolling oceanic waves would be at once manifest. In the case of the dune-wave all we in reality see is the position it has last assumed. There is one important difference between these two categories of wave to which we shall return again lower down, namely the fact that the velocity of oceanic waves increases as the waves increase in magnitude, whereas the opposite is true of sand-waves.

If we study the paths followed by the sand-particles in the wave-movement of a progressive dune, we shall find both resemblances and differences between them and the paths followed by the water-particles in oceanic waves. The water-particles in an oceanic wave travel along a cycloidal path in a vertical plane in the direction in which the wave is advancing. »Es sind also zwei Bewegungen zu unterscheiden: einmal die oszillierende oder Orbitalbewegung der Wasserteilchen und zweitens die fortschreitende der Wellenform.»* This path of motion is called a trochoid. The water-particles do not participate in the trochoidal, only in the orbital, motion. In the course of a dune's advance, the different sand-particles describe different paths according to the positions in which they last came to rest on the leeward slope of the dune. A sand-particle which falls all the way to the base of the leeward side of a dune, and repeats its completed movement during several periods, does indeed describe a path in a vertical plane in the direction in which the dune is advancing, but it is a path that is not cycloidal, because there occurs an interval between every two successive periods, so that what we have is rather a species of continuous trigonal movement (*vide* vol. I, pp. 273—274). Sometimes the particle lies on the crest of the dune, sometimes at its base, but with the entire dune-mass resting upon it. A water-particle, however, that happens to be on the surface, remains constantly on the surface, whilst at the same time it describes its orbital movement every time a fresh wave reaches it — assuming of course that the conditions remain constant. This is also apparent from the following simple definition by Forel — in which incidentally several resemblances between sand-waves and oceanic waves are pointed out: »Wellen sind langgestreckte unter einander parallele Wasserrücken, die Wellenkämme oder Wellenberge, zwischen denen die Wellenthäler liegen. Wellenkämme und -thäler bewegen sich gleichzeitig und mit gleicher Geschwindigkeit vom Entstehungsort der Welle fort und zwar so, dass während einer ganzen Periode der Welle derselbe Oberflächenpunkt des Wassers der Reihe nach einem Wellenkamm, dann einem Wellenthal und schliesslich wieder einem Wellenkamm angehört.»** Suppose we have an absolute fluid; it is conceivable that it might have a motion which in this respect resembles the motion of sand, i. e. rolling. If, for instance, we let drops of water fall upon a dusty, inclined table, they roll in precisely the same way as dunes do: a given point on the circumference of any drop which may at one moment be uppermost may at the next moment have the whole of the drop to which it belongs resting upon it. A similar phenomenon may often be observed in Northern Tibet, where in summer some of the smaller eroded watercourses carry water in the afternoon only, because it is not until then that the water is able to get down from the regions in which the snow is melting. You hear the water coming roaring down the dry watercourse, you see its advancing front rolling on like a muddy, turbid eagre, and it is quite easy to see that in its front a rolling movement is taking place, in such sort that the water-particles which recently rode at the top are now underneath. There is a third, and even more important, instance to which I shall revert presently; but before I do so, I wish to direct attention to the different paths described by a point (1) on the periphery of a circular cylinder, which is rolled by hand along a table-top — we have then the trochoidal path which we find again in the wave-movement of a fluid; (2) in an elastic cylinder, which is rolled along the table in the same

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* Krummel, *Handbuch der Ozeanographie*, II, p. 3.

** *Handbuch der Seenkunde*, p. 64.

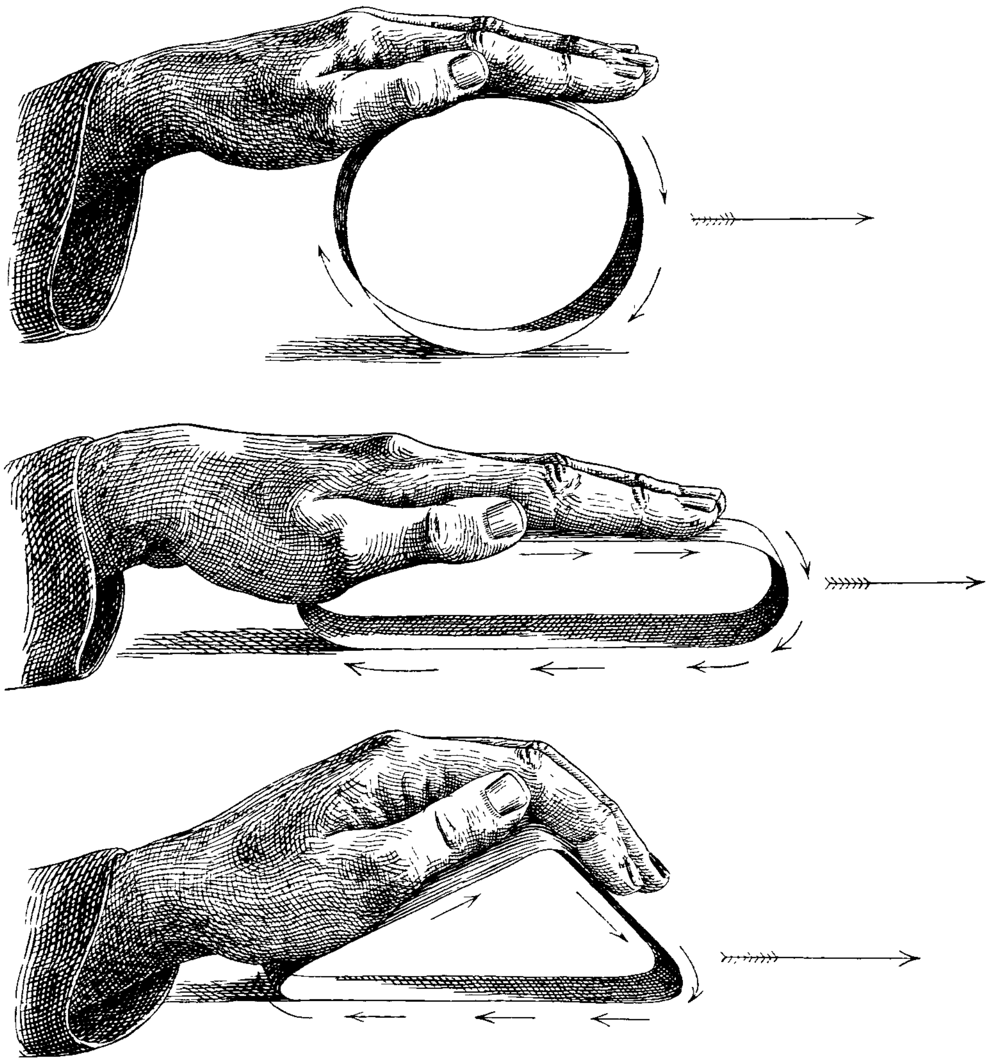

Fig. 184.

way, but is at the same time pressed down by the hand — this reproduces the movement of a viscous fluid like lava; (3) in a similarly elastic, but triangular cylinder, which, whilst retaining its triangular form, is rolled along a plane surface — the path of the sand-particle on the surface and base of a dune. Strictly speaking, there is no motion on the under side of a dune, although the sand-particle does alter its position in relation to the mass of the dune, in that the progressive movement of the dune gradually brings it nearer to the leeward edge of its base. The difference between the orbital movement of the wave and the movement of the sand-particle will become clear by a comparison of fig. 185 with fig. 186. In the former the water-particles describe their vertically revolving paths in one and the same position, whereas the sand-wave keeps moving forward. The oscillatory or »swinging« movement of such a water-particle is in part progressive, in part retrogressive, and the water-particle constantly returns to the same point, say the apex of the orbital revolution. In fig. 186 the triangle $a$ $a_1$ $a_2$ stands for a dune; $b$ $b_1$ $b_2$ for the same dune after a short advance; and so on until the dune reaches the position indicated by $x$ $x_1$ $x_2$ ($= m_1$). Upon reaching the position $k$ $k_1$ $k_2$ (for the sake of clearness $k_2$ is not shown), the dune has completed a full period; and a sand-particle, which was at $a_2$, has, in relation to the dune-mass, described its vertical triangular revolution, because it is there once again at the leeward edge of the base of the dune. Theoretically the angle in the path of the sand-particle is not the same at $a$ and $k$; but it is somewhat less acute, because the dune, during the advance of the sand-particle up the windward side and its descent down the leeward side, itself progresses a little, so that the angle is in reality rather more obtuse than that of the dune. The actual path described by the sand-particle is shown in the blunted triangle $ABC$—$N$-$U$, though of course immensely exaggerated in relation to the progressive movement of the dune. The dune advances but an infinitesimally short distance, so that the velocity of the sand-particle is immensely the greater; for, while the dune $a$ $a_1$ $a_2$ is travelling to $b$ $b_1$ $b_2$, the sand-particle advances to $B$, and so on; and when it has reached $N$, it drops down the leeward face of the dune and assumes

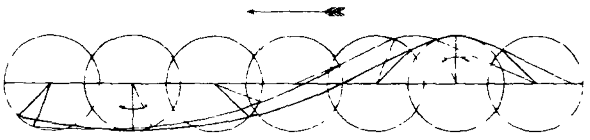

Fig. 185.

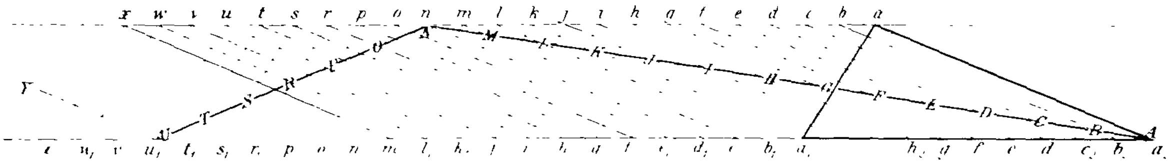
x w v u t s r p o n m l k j i h g f e d c b a
N M L K J I H G F E D C B A
O P R S T U
Y
h g f e d c b a

Fig. 186.

the position $U$, whilst the dune as a whole has at the same time advanced intermittently by infinitesimal increments of space until its crest has assumed successively the positions *a b c d e f . . . u*. When the leeward side has advanced to $vv_1$, the sand-particle is already buried, and when the leeward side has reached $Y$, the revolution is beginning again. During that portion of the revolving period in which the particle is on the top of the dune, it moves incomparably faster than the dune itself; but when it lies underneath the dune, the velocity of the latter is immensely greater than the velocity of the sand-particle, in fact the latter then = 0. The sand-particle's period is thus divisible into two stages; the stage in which it belongs to the windward and leeward slopes is very short, while that in which it belongs to the under side of the dune is on the contrary very long. This circulation applies of course only to single dunes; in the case of dune-accumulations the process is naturally more complicated. And even in the case of single dunes the process is more complicated than our figure shows, for similar periods occur even in the ripple-marks. In outline therefore the figure may also serve to illustrate their revolutions, as also the revolutions of the dune-accumulations. The difference between sand and water is therefore in this respect this, that the dune must advance a distance equal to the whole of its own base before the sand-particle is able to complete its vertical path, whereas the water-particle completes its orbital movement, and returns to its point of departure, during the time that the wave-movement advances onwards, away from it, at a much greater velocity. But in both cases alike a full wave-length is required for the completion of each vertical path, i. e. a complete period.*

We have seen that the advance of the dune involves a transportation of matter, but the advance of the waves involves only a transmission of movement without a transportation of matter. But just as motion can be imparted to solid matter, e. g. the crust of the earth during an earthquake, so also the wave-movement of water can carry with it or involve a transportation of mass. It is not therefore proper to compare dune-movement with wave-movement; for were it not that the sand-particles lack cohesion, the same kumatic motion could be imparted to a sand-field that is imparted to the solid crust of the earth. The dune-movement ought properly to be compared only with the condition that the surface of a sea or lake assumes when the crests of waves are broken and pour on over themselves in the form of spray. In order to make this plain I must once more quote Krümmel.

Airy has proved, that at the moment when a wave is rapidly increasing in height, the force of the wind raises it so high that its inherent continuity is ruptured, and the crest becomes broken by the wind. And the waves continue to pour over until their altitude, and with it their orbital velocity, reaches its maximum value, which is conditioned by the strength of the prevailing wind. The crests of the waves continue to pour over until they attain their maximum height; but once

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* Mr O. Baschin says: «Es finden bei der Entstehung sowohl der Wasserwellen und der Luftwogen, wie auch der wellenformigen Anordnung lockeren Sandes, Staubes oder Schnees dieselben physikalischen Gesetze Anwendung, und dieselben Krafte sind es, welche die Wellenformen erzeugen. Unterschiede bestehen nur hinsichtlich der Dimensionen und hinsichtlich der durch die Verschiedenartigkeit des Materials bedingten Formen.» *Zeitsch. d. Ges. f. Erdk. zu Berlin*, vol. XXXIV. p. 423.

LEFT SIDE OF GLEN THAT DEBOUCHES UPON SANDY DESERT, AT CAMP CXXXIV

*Ljustr. af B. Lagrelius & Westphal*

BUSH OF SAKSAUL, IMMEDIATELY OUTSIDE SAME GLEN

that limit is attained, the waves become rounded in outline and the crests are no longer broken.

»Indes kann das Überstürtzen der Wellenkämme doch nur in dem Sinne wirken, das durch die vorwärts geschleuderten und in die Tiefe eindringenden Wassertropfen die Impulse in die Richtung des Windes sich schneller in die Tiefe fortpflanzen als die Formeln ergeben: ein Prozess, der noch durch das Empordringen von vorher tiefer gelegenen Wasserteilchen an die Oberfläche, an die Stelle der vom Winde abgerissenen und hinweggeführten unterstützt wird. Durch schnelle Steigerung der Wellenhöhe wird dann die Differenz zwischen der Wind- und der Orbitalgeschwindigkeit der Wasserteilchen kleiner und so das Stadium der 'ausgewachsenen' See erreicht, wo die Windstärke nicht mehr ausreicht, den Zusammenhang der Wasserteilchen zu zerreissen.»[*]

But these results, that ensue from the increasing height of the waves, play no part whatever in sand-waves: the crest of a sand-wave only a decimeter high pours over itself equally as the crest of a sand-wave 100 m. high. The difference between the velocity of the wind and the velocity of the paths of the sand-particles in the vertical plane is always so great, that the successional continuity of the particles themselves is broken and the crest must pour over under any and all circumstances, assuming of course that the impact of the wind is at right angles to the dune. The passage I have just quoted shows also clearly, that, when sea-water is agitated to the point of breaking into spray, the water-particles in each wave show a tendency to rearrange themselves, which is fully comparable to the rearrangements that take place within a dune-wave. Those particles which have recently been on the summit of the wave plunge down its steep leeward side to its base, and then perhaps in the next moment lie at the lowest level of the wave. Later on they again emerge upon the surface, and take the place of those particles which in consequence of the continued over-pouring of the wave have been forced down towards its base. Hence, even in the case of an oceanic wave, we may speak of a rolling motion of the same kind as that of a dune – indeed there is a species of over-pouring wave which is called a ›roller‹. Add to this, that the crest of the wave is broken and pours over in the form of breakers so soon as the depth becomes less than the altitude of the wave. A contrary current tends to produce breaker waves; and Krümmel says: »Besonders hohe Wellen und heftige Sturzseen sind lokal dort häufig, wo die herrschende Dünung einer Strömung entgegenläuft: so in Flussmündungen, im Gebiete starker Gezeiten- oder besonders starke Meeresströme. — In diesen Fällen werden die von der Welle ergriffenen Wasserfäden im Bereiche des Wellenkammes durch den ihrer Bewegung sich entgegenstemmenden Druck der Strömung stark zusammengepresst, wodurch die Kämme höher und steiler werden und schliesslich wegen mangelnder Unterstützung überschlagen, und zwar in der Richtung dem Strom entgegen.«[**]

A similar effect is produced upon waves that are beating against a beach by their own back-wash or recoil; they set up a bottom current which flows in the opposite direction to themselves, and consequently arrests the lower parts of the advancing wave-sections (vertical), causing the whole of the wave-crest to curl over against the shore, and forcing it to break over and form breakers. In this latter case it is therefore the increased friction between two different layers of water that gives rise to the pouring over of the crest of the wave. I several times observed the same thing in the Tarim: for instance, when the river was flowing towards the east and the wind was blowing from the same quarter, there arose small waves, with steep transverse crests, which broke over and, even when the wind was not very strong, were tipped with white spray. In consequence of the current these waves were however almost stationary. But breaker waves occurred also even when there was no wind, for instance where two branches of the river met, each flowing with a swift current.

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[*] Krummel, *Handbuch der Ozeanographie*. II. p. 350.

[**] *Op. cit.*, p. 83

Since then increased friction, that is to say the arrest of the under side of the water, when taken in vertical section, in waves of any and every height gives rise to breaker crests, we have precisely the same phenomenon that we find in drift-sand. In this the friction between two layers of sand is always immensely greater, and consequently even the smallest dune-wave is forced to pour over, because the sand rolls down its leeward side, exactly as the water does. In the sand however no bottom current is needed, and the depth of the 'sand-sea' is immaterial; for friction is under all circumstances present, and an under layer of sand, even though lying close beneath the surface of the dune, always performs the same function that the bottom of the sea does for the wave. Sand-waves therefore always form breakers and rollers, so that the only thing with which dune-formations can properly be compared are the breakers of the sea, or generally over-pouring wave-crests. It is therefore improper to compare them with ideal wave-movement and its orbital paths. The orbital paths of breakers are as little cycloidal as are those of the sand, and in their case a water-particle, swinging in a vertical plane, does not return to its point of departure, but, like the sand-particle, simultaneously advances a short distance in the direction of the impelling force.

Both in water and in sand a similar transportation of material takes place under yet another form. Theoretically the effect of a constant wind blowing upon a sand-field is to sweep it away down to the very last particle of sand; and this would also follow practically, were it not that fresh sand, produced by disintegration, is constantly being brought up by the wind. In this process of the forcible removal of the sand-field the formation of dunes constitutes one phase, or a phenomenon that is intimately related to mass-transportation, because the agency that effects the removal of the sand is just this of the periodical revolution of the sand. How plainly the same phenomenon is repeated in the ocean! Krümmel says upon this: Es ist daran festzuhalten, dass die Triftgeschwindigkeit jedenfalls bei starken Winden grösser wird, als bei schwächeren, trotz der Wellenbewegung, die ja schon bei sehr geringer Windstärke sich einstellt. — Aus den Beobachtungen der Seefahrer ergiebt sich sogar, dass die 'turbulenten' Bewegungen an der Meeresoberfläche bei gleichbleibender Windstärke nur eine vorübergehende Durchgangsphase der Wellenbildung vorstellen, dass vielmehr bei 'ausgewachsener' See das Überfallen der Kämme sich vermindert oder gar aufhört. Dann aber dürfte jedenfalls die Trifterscheinung sich ganz normal vollziehen.»[*]

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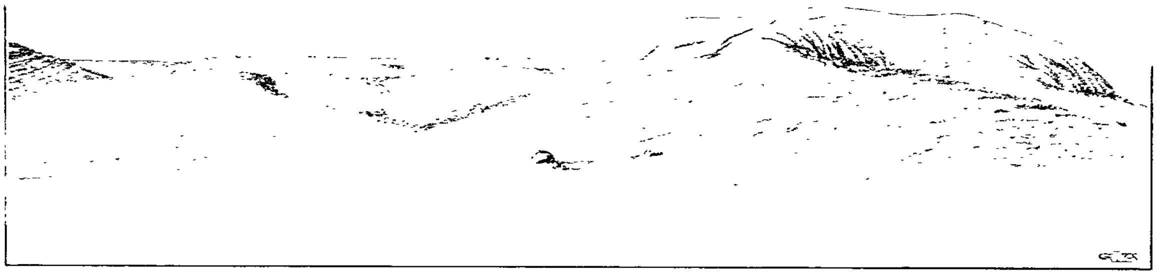
[*] *Op. cit.*, p. 349.

Speaking of the origin of the ocean currents, Hann says, that the movements which are now taking place in the oceans of the earth are a summation of the effects produced by the winds during thousands upon thousands of years. In this case too the wind has been labouring to carry away, as it were, the water, though equilibrium tends just as constantly to counteract its labours by bringing in equivalent quantities of water from the windward. If, owing to certain external conditions, this re-supply cannot be effected, the result is that an accumulation of shallow water may be blown by a fierce wind completely out of its containing basin, as I once saw between the Kara-buran and Tscharklik. In a word, water is subject to the same mass-transportation as sand; as we see, when we compare analogous phenomena in the case of both elements.



A SAND-DUNE NEAR ANAU IN TRANSCASPIA.

That I may still further emphasise and define the difference between wave-movement and mass-transportation, I will quote Supan, who shows how the former originates, when, for example, an object is flung against a water-surface, and how the motion is propagated until friction overcomes the force of inertia. »Der Wind dagegen ist eine kontinuirlich und horizontal wirkende Kraft und sollte die Wasserteilchen vor sich herschieben. Und dies ist in der Tat auch der Fall, der Wind erzeugt ebenso Strömungen wie Wellen, und die Frage ist nur die, wann erzeugt er die eine, wann die andere Bewegungsart, und wie gehen beide ineinander über? . . Wenn der Wind lang genug aus einer und derselben Richtung weht, wird die Tendenz immer grösser, die Wasserteilchen in dieser Richtung auch wirklich weiterzubewegen, so dass die Orbitalbahnen nicht mehr geschlossene Kurven bilden, und jedes Wasserteilchen am Ende einer Schwingung von seiner früheren Lage etwas abgerückt ist. Daraus entstehen die Triftströmungen . . .»*

It is only with this phenomenon that movements in sand admit of being directly compared, for sand possesses a great amount of friction, but is destitute of the moment of inertia, and consequently lacks the power of progressive wave-movement.

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* *Handbuch*, p. 267.

# CHAPTER XXIX.

## SAND-CURRENTS — RIPPLE-MARKS, WAVES, AND DUNES.

As the atmosphere possesses its regular, uniform currents, and the hydrosphere its similar currents, so also the lithosphere, or solid crust of the earth, exhibits its real currents. It sounds paradoxical to say, that not only the gaseous and the fluid envelopes of the earth, but also its solid envelope, is able to form currents; and yet so it is. Mass-transportations on the earth's surface take place of course under countless different conditions, and in intimate connection with denudation, the levelling of the surface, disintegration, sedimentation, the formation of alluvium, the heaping up of æolian matter in immense deposits, volcanic phenomena etc. etc. Yet it is not of these I desire to speak, but of the mass-transportations of drift-sand which take place in regular currents on a stupendous scale, currents that are equivalent to the regional and horizontal currents of the atmosphere and the ocean. These three species of current in different aggregational conditions are of course initiated by different impelling forces. Atmospheric currents are set up by differences of atmospheric pressure; oceanic currents by the retarding friction of the atmospheric currents as they pass over the surface of the water; and drift-sand currents likewise by the mechanical lifting force of the currents of the atmosphere. The limits or bounds within which these three species of current flow are very unlike one another. Those of the atmosphere are extremely faintly defined, and their geographical positions are very changeable. The limits of the oceanic currents are far more sharply defined, and their boundaries fluctuate far less. But it is the limits of the sand-streams that are the most sharply defined of all; in most cases they admit of being delineated, even on large scale maps, with the greatest distinctness of outline. An oceanic current that is maintained by a wind blowing from a constant direction is influenced but little or not at all, and in any case only superficially, by a local change of wind. This holds good also of the sand-currents, as we saw in the Desert of Tschertschen. In the former case we have over-pouring waves going over in a direction contrary to the current; in the latter case the dune-accumulations maintain their usual position and form, but of the individuals composing them those that are uppermost and on the extreme outside are compelled to turn their steep leeward faces towards the direction from which the prevailing wind generally comes. On the other hand it is a necessary implicate of their very natures, that oceanic currents and sand-currents are never able to come into collision with one another; for their domains are so extremely unlike that they scarcely come into contact with one another even at their boundaries, except perhaps occasionally in the case of littoral dunes. Nevertheless water in another form can and does come into collision with sand-currents, as we have seen in the lower Tarim, and as is the case in the lower Amu-darja; and the effects produced by the friction, and the wear and tear thereby occasioned, are extraordinarily great.

One important difference between sand-currents on the one hand and aqueous and atmospheric currents on the other is, that while the latter set up counter-currents for the purpose of restoring equilibrium, there exists no corresponding relation of cause and effect in the case of the former, which simply progress in one direction, and continue to advance time after time in that same direction so far as the boundaries of their basin and the impelling wind will allow them to do. It is only in so far as it attempts to counteract the difference of elevation occasioned by the building up of mountain-ranges that a sand-current can, so far forth, be regarded as an agency for restoring equilibrium; but this is entering upon a different domain, in which drift-sand plays the same part as loess and sedimentary deposits.

In addition to the resemblances which I have pointed out as existing between movements in sand and movements in an absolute fluid, there are of course numerous others, such as the power which the surf possesses of forming very high waves on a rocky coast, a situation which is clearly reflected again when a sandy desert impinges upon the foot of a mountain (see below, The Gobi Desert); but the instances already cited are sufficient to illustrate the resemblance between the effect which the wind produces upon water and upon sand. There is however one other point of comparison remaining, and it brings us to the question with which I began this series of reflections, namely how far ripple-marks may be regarded as dunes in an embryonic stage, as Cornish considers them to be.

Let us therefore, even now, consider an analogous condition in the case of a fluid, e. g. water, and see what Krümmel has to say about it. He begins by reminding us of what is a matter of common experience, how the smooth, bright sheet of water is clouded by the morning breeze, how it then becomes slightly ruffled, and how the little rufflings increase in size from windward to leeward in proportion as the wind gathers strength. When you row out in a boat from the shore off which the wind is blowing, you can distinctly see the waves growing bigger in size. »Sind nun einmal erst jene embryonalen oder kapillaren Wellen vorhanden, so hat es keine Schwierigkeit, das Wachstum derselben unter der weiteren Einwirkung des Windes bis zu den grossen 'Seen' des offenen Ozeans zu erklären. Die weitere Ausbildung erstreckt sich sowohl auf die Umformung der kurzen, schwach gebogenen, in lange geradlinige Kämme, wie auf die Zunahme aller Dimensionen. Hierbei kommen nun die kreisenden Bewegungen der Wasserteilchen in der Welle in Betracht. Im Wellenkamm, im oberen Scheitel, bewegen diese sich ohnehin mit dem Winde vorwärts: der Wind wird also ihre Tendenz nach vorn stetig beschleunigend verstärken . . . Je länger also der Wind auf die ursprünglich so kleinen Furchungen einwirkt, um so grösser wird er die Amplituden der Orbitalbahnen machen, d. h.

um so grösser werden zunächst die Wellenhöhen werden. Airy hat diese Prozesse sogar einer analytischen Rechnung unterworfen . . . Er zeigt in höchst interessanter Weise, wie gerade eine horizontale äussere Kraft vorzugsweise geeignet ist, die Wellenhöhen zu vergrössern. Denn da in dem oberen Scheitel der Welle alle Teilchen nach oben sich bewegen, so wird beim Hinzukommen eines horizontalen Impulses, wie der Wind ihn gibt, die Resultierende aus beiden Bewegungen die vertikalen Komponente immer mehr vergrössern.»* Supan expresses the same opinion in the following words: »Sobald die völlig ruhige See von einem Winde mit mehr als 0.2 m. Geschwindigkeit in der Sekunde getroffen wird, entsteht eine leichte Kräuselung des Wasserspiegels. — Die Oberflächenschicht, die sich bei jeder Flüssigkeit in mancherlei Hinsicht wie eine selbständige Membran verhält, legt sich in Falten, wie die Haut am Handrücken, wenn man mit dem Finger darüber hinwegstreicht... Die Fältchen oder die kapillaren Wellen, sind es nun, die dem Winde neue Angriffspunkte bieten und immer höher zu wirklichen Wellen anwachsen. Je grösser der Raum und die Wassermasse ist, desto ungehinderter kann diese Entwickelung vor sich gehen; das Meer ist daher der eigentliche Schauplatz grosser Wellenbildungen.»** It is therefore quite natural, that small waves should arise on the surface of the big waves: »Weht der Wind in unregelmässigen Stössen oder gar in Böen, so beobachtet man leicht, wie auch die dann vorhandenen grösseren Wellen an ihren Dossierungen, besonders der Luvseite, sich mit jenen kleinen Kräuselungen überziehen, welche, wie wir sahen, die ersten ursprünglichsten Elemente einer neuen Wellenbildung vorstellen.»***

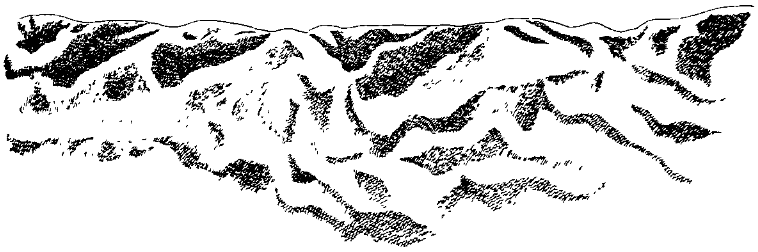

Fig. 187. RIPPLE-MARKS ON THE CREST OF A DUNE. DESERT OF LOP.

The simple reason why these small parasitic waves do not develop into big ones is that they are absorbed by the latter, and have neither opportunity nor power to develop themselves before they are absorbed. Ripple-marks are nothing but embryonic, parasitic dunes, which are formed on the surface of the large dunes in the same way as the faint rufflings originate on the surface of the large oceanic waves. Intermediate stages between ripple-marks and miniature dunes of, say, 1 dm. in altitude no more form on completed dunes than they do on the crests of oceanic waves, and the reason is that the windward sides of even the biggest dunes are all too short to allow of the ripple-marks reaching any noteworthy degree of development. Before that can happen, they, owing to their relatively swift advance, already have reached

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* *Handb. d. Ozeanographie*, pp. 60—61.
** *Grundzüge d. Ph. Geog.*, p. 267.
*** Krummel, *Op. cit.*, p. 55.

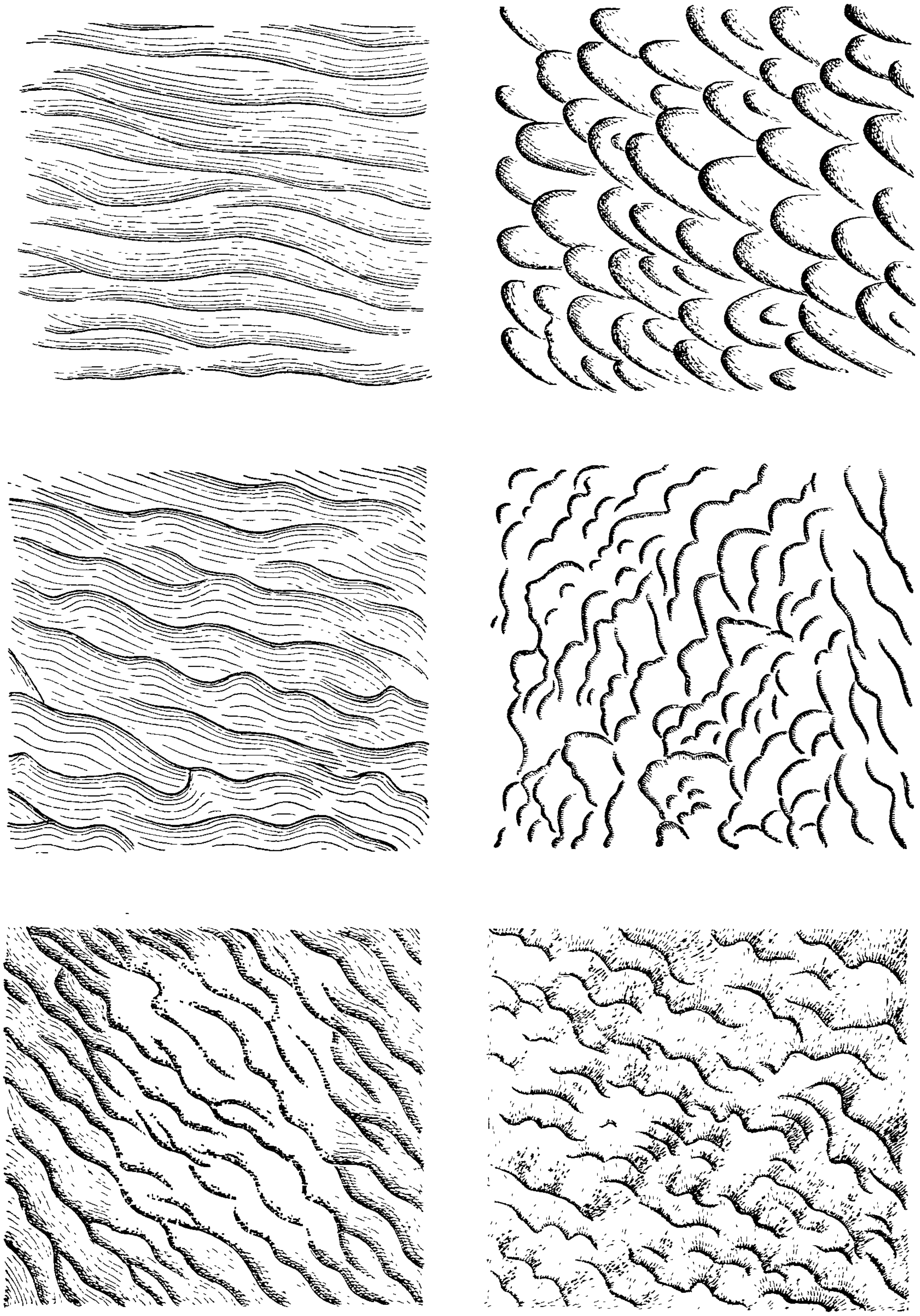

Fig. 188. DIFFERENT PATTERNS OF RIPPLE-MARKS. DESERT OF LOP.

the crest, where they at once plunge over and disappear on the leeward side. But that they do increase Cornish has proved experimentally. »In a few minutes the surface became rippled, and the ripples grew in height, in wave-length, and in regularity, under the constant blast.»* Supan also says, and rightly: Sobald das Sandhäufchen kaum 1 cm. hoch ist, nimmt die Leeseite die natürliche Böschung an; die Luvseite ist stets sanfter geneigt, an ihr bewegen sich die Sandkörnchen aufwärts, um auf der Leeseite hinabzufallen.»**

The annexed cuts (p. 429) reproduce examples of ripple-marks from the dunes of the western Desert of Lop. They are of divers patterns, depending upon the shape and slope of the dunes, and upon the angles at which the wind impinges, as also upon the magnitude of the sand particles. There exist also limits to the origination of ripple-marks, dictated by the size of the particles. Fine gravel, being too heavy for the wind, forms no dunes, nor fine dust either, for the reason that it is too light to adhere to the surface in a hard wind. The ripple-marks are on the leeward slope long and straight (see fig. 188), and the difference between their two slopes is often in this respect very slight. But a closer examination of the ripple-marks on the windward slope will often reveal the fact, that some of them reproduce to some extent the crescentic shape of the individual dunes, although it is seldom that that formation is found, because these embryonic dunes, the ripple-marks, seldom have an opportunity to develop individually, but are always associated in long rows like the chains of dunes; that is to say their wings coalesce with those of their neighbours. Yet two things there are distinctly noticeable in the ripple-marks that are formed on the windward side of dunes, namely they have themselves a gently ascending windward face and a steep leeward face.

A very soft breeze is unable to make the rufflings of a water surface swell into waves, because friction and the moment of inertia of the water are greater than the force of the wind; and it is only when the wind has succeeded in overcoming the resistance implicit in the water that the rufflings do succeed in growing as big as waves. At first a sudden and violent squall gives rise only to the same sort of fine ruffling of the water; but if the wind continues, these rufflings rapidly assume the dimensions of waves; so that waves thus express the summation of the work the wind has accomplished during a certain period. Dunes also are an expression for the accumulated labour of the wind acting during a certain period; while ripple-marks, on the other hand, may originate and be totally changed in the course of one or two seconds. Any one who has been on the windward side of a dune when the wind has been blowing cannot have helped noticing, how the ripple-marks, especially in squally weather, keep continually changing their shape and character in accordance with the steepness of the dunes and their position relatively to the wind. They put one in mind of the delicate wrinklings of the skin on the inner side of the hand or at the tips of the fingers. Some of the patterns they assume are shown on Plate 51 of vol. I. When the surface of a dune is studied in absolutely calm weather, its surface is always found to be covered with ripple-marks. From them one is able to read directly, as upon a self-registering instrument, from which direction the wind

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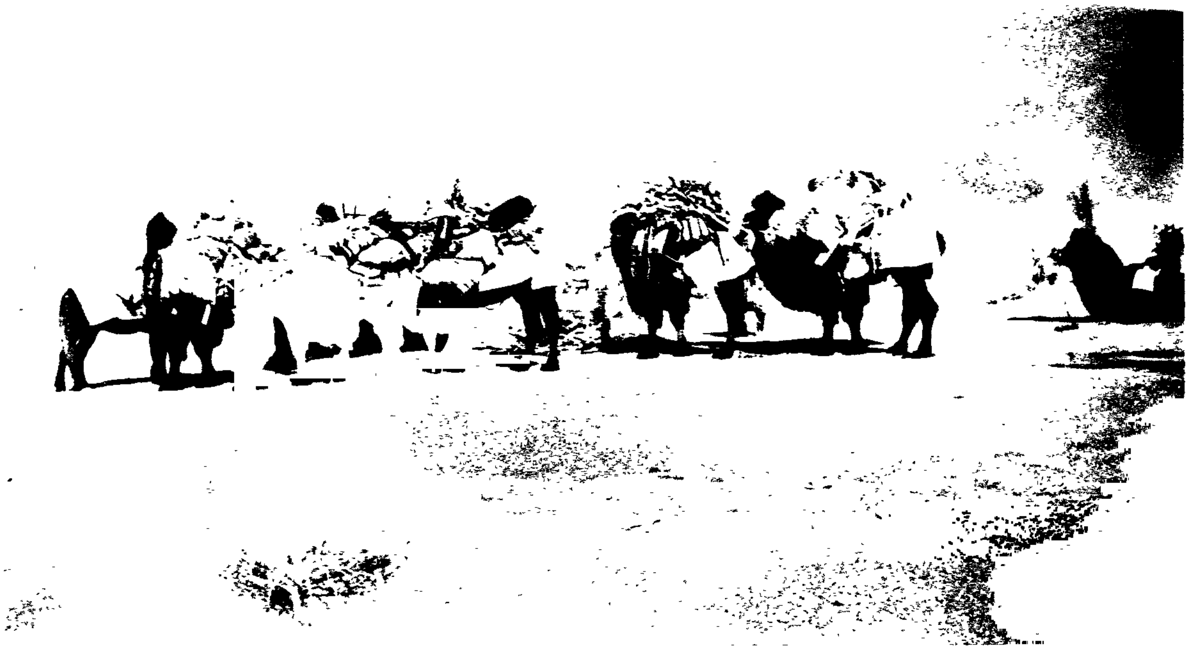
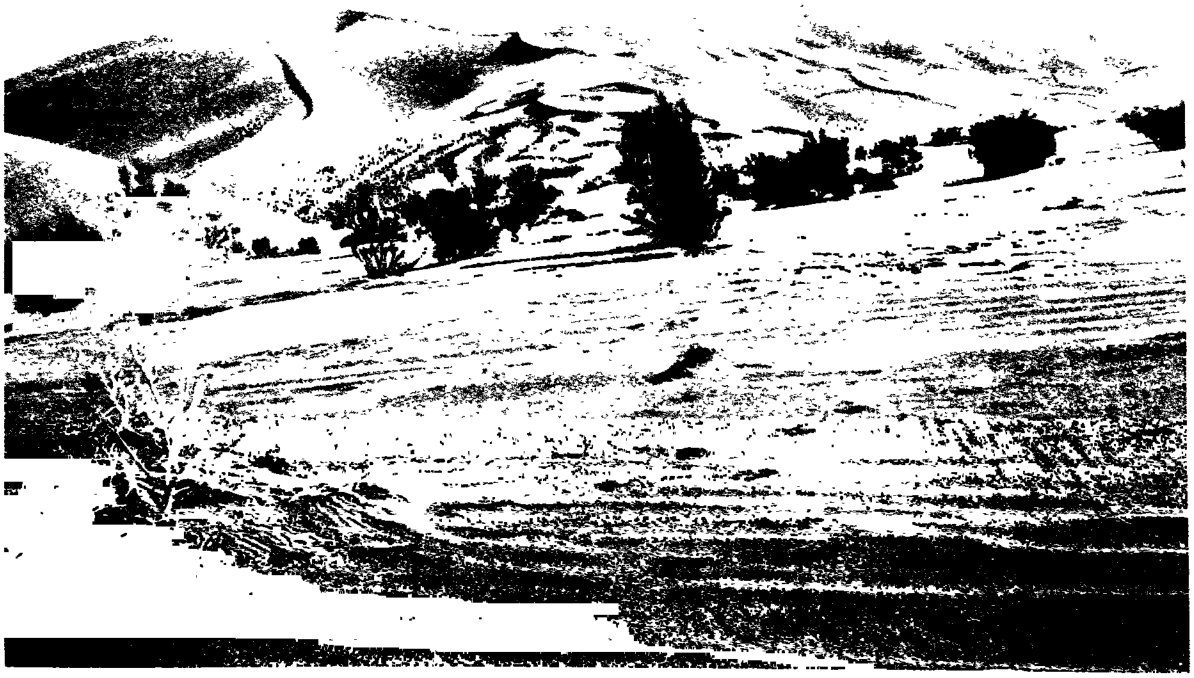
* Already quoted on p. 410 above.

** *Op. cit.*, p. 505.





Ljustr A B Lagrelius & Westphal

CONTINUATIONS OF SAME GLEN IN DESERT, VIEWS TAKEN BETWEEN CAMPS CXXXIV AND CXXXV.

came when it last blew across the dune; though it is at the same time probable, that since that happened some breeze or other has passed over, which has been too weak to displace the individual particles of sand. If then, under these circumstances, a wind springs up, making with the wind that last blew an angle of, say 30°, the whole of the ribbings will have totally changed their position. The same patterns re-occur in principle, but it is on another slope.

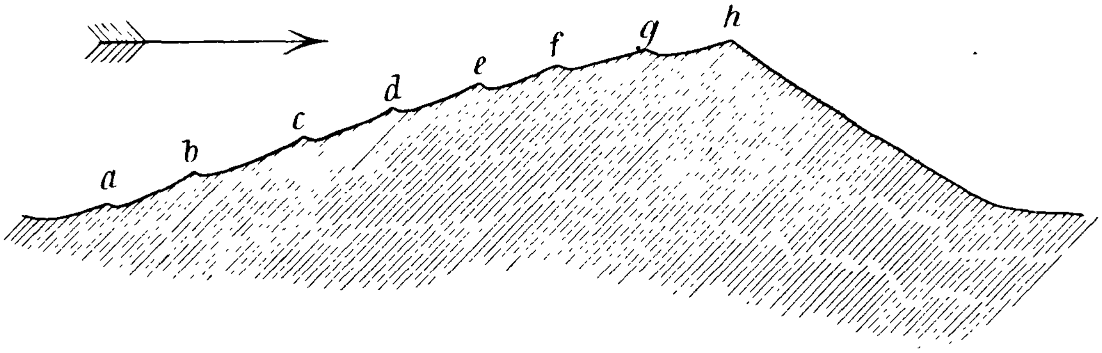


Fig. 189.

A dune will continue to increase so long as it is exposed to a constant wind, that carries with it a constant quantity of drift-sand. The fact that it is simultaneously progressive makes no difference, for the rate of progress is so small that it may be taken as negligeable when compared with the velocity of the wind. If then the dune grows and increases in size, it must from the beginning have been immeasurably small. Geological text-books tell us also, that the minutest obstacle is sufficient to give occasion for the origination of a dune. It would however be impossible to look for this earliest germ of the dune; for not only is the ground always so far uneven or full of minor irregularities that a tiny dune of this description never gets an opportunity to originate in a regular way, but a solitary ripple-mark would never, by reason of its lightness, remain *in situ* in the wind, but it would travel along the ground with almost the same velocity that the wind does, and the sand-particles would be dissipated. An embryonic dune is only able to maintain its position when its mass offers a sufficient amount of resistance to the wind. Its windward side is then so short that it affords no room except for a very few ripple-marks; but on a full-sized dune the ripple-marks may be counted by the hundred, all arranged in more or less parallel lines. In fig. 189 we see the profile of a dune, the

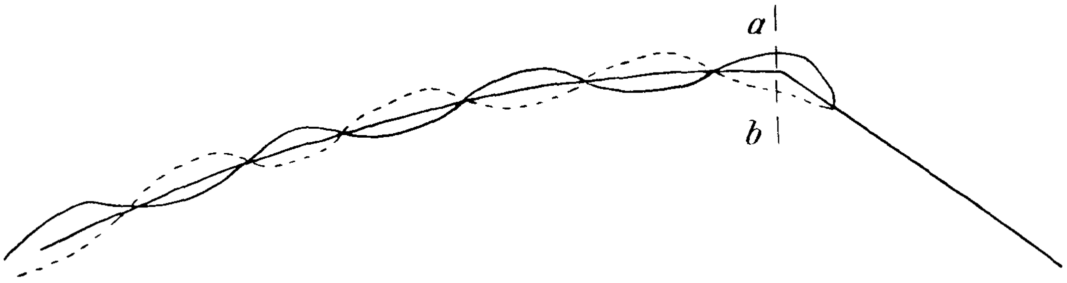


Fig. 190.

windward side of which is covered with a series of ripple-marks. In a strong wind these travel with a velocity which must no doubt be a hundred thousand times greater than that of the dune itself; the difference increasing proportionally with the dune, partly because the velocity of the dune's progress decreases proportionally to its mass, partly because the ripple-marks advance faster in proportion as they become more exposed to the wind. The ripple-mark *a* travels up towards the crest of the dune through the stadia *bcd* . . . etc. When it reaches the crest of the dune (fig. 190 ), it plunges over it, the level of the dune-crest varying at a given point, or rather in the vertical line *a*—*b*, according as the crests or hollows of the ripple-marks surmount it. The extent of this oscillation is equal to the wave-height of the ripple-marks, and the period of the pendulum-like swing of the dune-crest on the vertical line is equal to the period of the ripple-marks themselves. As fast as the ripple-mark *a* (fig. 189) advances to the position *b*, a new wavelet is created at *a*, and so on. In a word, fresh wavelets keep coming into being without cessation at *a* and plunging over the crest at *h*. It is due solely and alone to this procedure that the dunes progress, and it alone explains fully how it is that, while the dune advances in the direction of the wind, it is likewise able to maintain its form and its definite individuality. Were it not for the successional creation of the ripple-marks, the dune would either be stationary or would gradually crumble to pieces, and disappear as the grains of sand were blown away. But since the dune does go on increasing in size, and the leeward slope does grow longer, the successive increments of sand which the ripple-marks make to its mass grow increasingly thinner, owing to the fact that the sand is spread out over increasingly larger areas on the leeward side, while the velocity of the dune's advance decreases at the same rate.

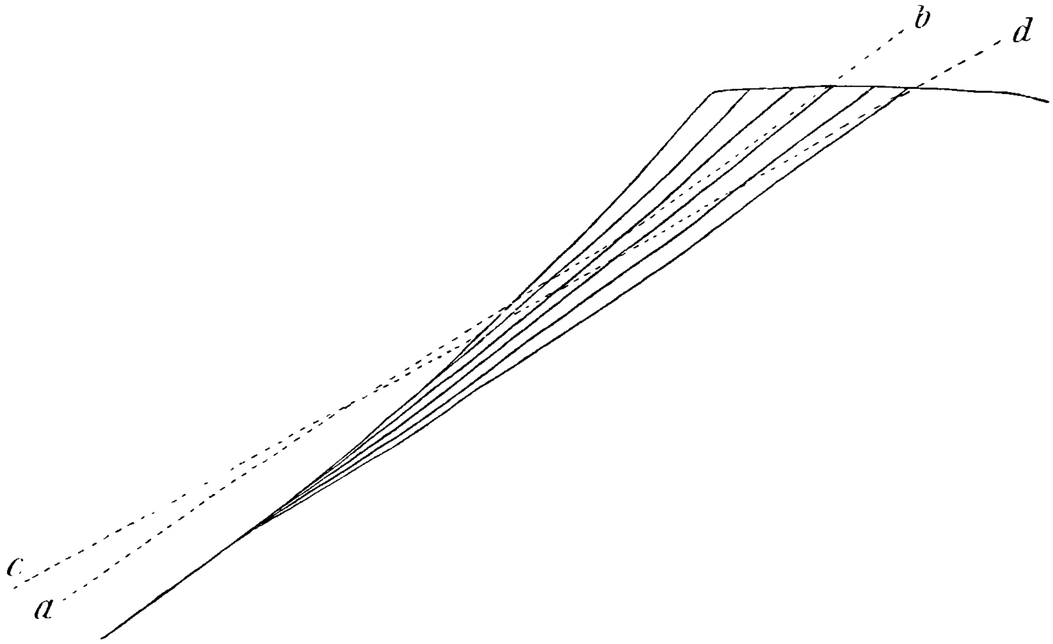


Fig. 191.

The crest-line oscillates also horizontally. The sand of which each ripple-mark is constituted tends to come to a standstill immediately under the crest, and its profile (see fig. 191) shows that it grows increasingly thinner as it descends. Owing to this the leeward slope acquires a greater degree of steepness than it is able to maintain, and in consequence of the gathering load on the crest, there is a sand-slip in the lower part of the leeward slope. This, it is true, endeavours to restore the angle *a—b*, which however in consequence of the moment of inertia in the movement of the downward sliding sand shoots forward to the position *c—d*. No sooner is this result achieved than the loading up begins again on the upper part of the leeward side of the dune. The horizontally oscillating period is more irregular than that of the vertically oscillating period.

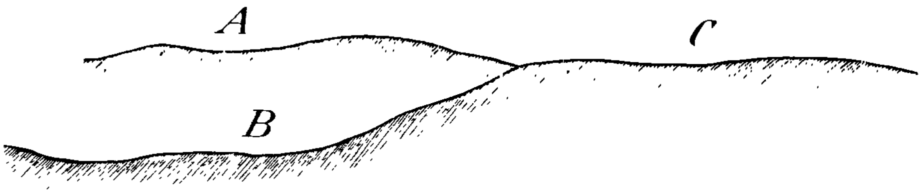


Fig. 192.

Seeing now that, as I have assumed, the ripple-marks augment in size as they advance, it might be expected that they would also advance at an increasingly slower rate in consequence of their augmenting mass, and that this process would be intensified in proportion to their proximity to the summit of the dune, and that consequently they would as a rule be overtaken by the ripple-marks that follow them. As an actual fact this does not happen, for not only is the augmentation of mass relatively insignificant in the short ascending paths which even the very biggest dunes offer, but the higher the ripple-marks climb, the more they become exposed to the wind, with a consequent increase of velocity, so that as a rule their rate of advance remains tolerably uniform all the way up the dune-side. Add to this the local deviation which even a constant and uniform current of air must experience when it impinges upon the irregular surface of dunes, in consequence of which the wind in amongst the dunes is generally gusty and squally. This may easily be observed when you get under the shelter of a dune: the wind then appears to come first from the one side, then from the other, of the dune's upheaval. The power which would be needed to effect the augmentation of the ripple-marks is therefore employed instead in altering their position, that is in deflecting them to the one side or the other.

All the same it is an extremely common occurrence for ripple-marks to swallow up one another. When two ripple-marks *A* and *B* (see fig. 192) merge together to form one, *C*, their mass becomes equal to the mass of $A + B$.* With regard to the primary origination of ripple-marks, Cornish writes:** »In order that ripples, the ridges of which are transverse to the wind, may be produced, the sand must contain an abundance of grains which offer sufficient resistance to produce an eddy. Groups of these give the mottled appearance which precedes the formation of regular ridges. These patches extend themselves transversely by a mechanism similar to that which increases the height of the ridges (the eddy opposing the direct current, and thus arresting the motion of the larger grains). The original patches thus quickly unite at their ends in transverse chains. The lateral dimension of the ridges increases much more quickly than the wave-length. I have known ridges increase from 2 inches to 20 feet laterally, whilst the simultaneous growth of wave-length was from 1 inch to 3 inches.'

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* Cornish gives in *Geog. Journal*, March 1897, p. 283, an instructive example of this.
** *Loc. cit.*, p. 282.

If now we assume — what is of course an impossibility in nature — an absolutely horizontal drift-sand area of the extent, say, of the Desert of Lop, the causes which in the above quoted passage are stated to prevent the ripple-marks from gradually growing into dunes would no longer exist, and consequently, under the circumstances supposed, the embryonic dune-waves would develop into real dunes. But these dunes would from the very first possess no individuality, because from the very fact of their being ripple-marks they would inevitably have already shaped themselves into connected lengths and rows, and these would continue to grow until they reached the size of the extraordinarily beautiful and regular accumulations that we find in the Desert of Tschertschen. How high their limit of altitude would ascend it is indeed difficult to say; but I have already mentioned, that there does exist a limit of altitude of this character, and that it bears some sort of direct relation to the increase in the force of the wind. This limit of altitude is also certainly dependent upon the volume of drift-sand which the wind brings with it.

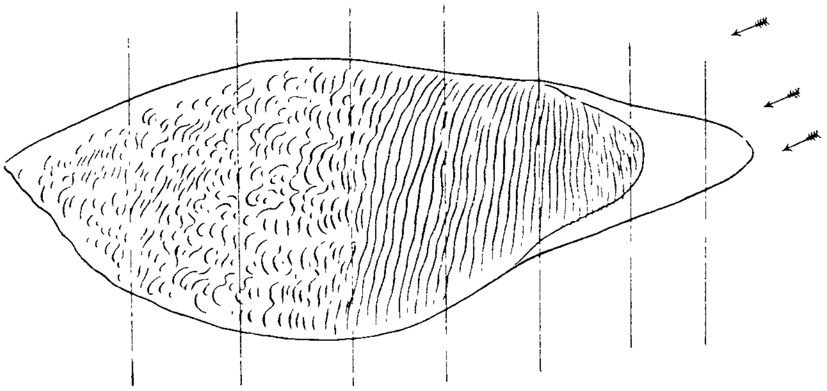

Fig. 193.

Fig. 193 represents an inland sea or large lake. Its extreme eastern part has been dried up; hence wave-formation is there out of the question. The wind comes, as the arrows indicate, from the east-north-east. In the extreme east of the actual lake, which lies under the shelter of its own shore, the wind in question elicits but the faintest rippling of the surface; but westwards the effect produced gradually assumes the form of waves, which finally reach a gigantic height, the greatest in fact which under the existing condition is admissible. Let us now take a farther step towards the west, that is to about the middle of the lake: there the wind blows with less constancy, and gusts from other quarters begin to make their presence felt, and thus the waves lose to some extent their previous regularity of shape. In the western half of the lake the winds are very uncertain, and the regularity in the relief of the waves comes to an end. In places the wind actually blows occasionally from the west, whilst still keeping on the whole to the predominant quarter, and consequently the waves are turned in the opposite direction. In this way there occur two sets of waves, meeting one another and rising into lofty pyramidal masses at the points of intersection. The hollow between two wave-crests in the eastern part of the lake presents but slight changes of level from north to south, in fact it is almost one uniform level throughout. In the middle and west the differences of level are much greater. A boat sailing before the wind, that is from west to east, would indeed be able to advance, although to do so it would have to dip up and down, over the crests and down into the troughs between them; but it would not be able to advance against the wind. In the middle and western parts of the lake these differences of level would be considerable in whatever direction you chose do go.

Who does not recognise in this description the Desert of Takla-makan and the Desert of Lop, or the sandy ocean of the Tarim basin? The masses of sand in this last present precisely the same relief as the waves in the lake described. Sand is entirely absent from the eastern part of the Desert of Lop; consequently even ripple-marks are unable to originate there. It is in the middle part of the desert that we first meet with a thin sprinkling of embryonic dunes, scattered over the clay surface. But towards the west these sand-waves increase in elevation until, along the line where we crossed the Desert of Tschertschen from Jangi-köl to Tatran, they rise as high as small mountain-ranges, which under the influence of the prevailing wind retain their regular form unimpaired. Still farther west, where the winds alternate, the drift-sand is flung together in inextricable confusion, and except for small patches of bare clay of irregular size and shape (though these occur very seldom), there is nothing but sand. The dunes are, it is true, heaped up into vast dome-shaped masses; but these are irregular and capricious in outline. In different localities the steep sides of the individual dunes face different directions, and are always short. The reason of this is that the individual dunes are there superficial, changeable, and transient; whereas in the Desert of Tschertschen the object of each individual dune is to increase the dimensions of the accumulation up the windward side of which it climbs, and thus contribute to the preservation and permanence of the shape of the accumulation, precisely in the same way as ripple-marks endeavour to augment and preserve the individual dunes, and as the individual particles of sand endeavour to form and maintain each separate ripple-mark.

In a word, after crossing, as I have done, the sandy desert of the Tarim basin along several different lines, the conviction is irresistibly driven home upon me, that the condition in which we find the masses of sand is precisely the same as that of the kumatic forms in the lake to which I have lately alluded. Both elements, sand and water, are very mobile, and readily lend themselves to shaping and modelling, and in both cases alike the modelling agency is the same. Why then should not the result be in both cases similar? The waves of the lake roll away wave by wave, flatten out, and some time after the subsidence of the wind present again the appearance of a mirror-like expanse; but the sandy waves remain in the positions they have assumed until fresh winds come to move them again. Moreover the latter advance increasingly slower in proportion as they grow higher, and so in the course of time they rise to colossal dimensions. But these considerations are of a secondary character, and do not in the very slightest degree affect the comparison I have instituted.*

Just as the oceanic currents may be said to be the result of the increasing activity of the wind through countless millennia of years, so may precisely the same thing be said of the dune-accumulations in, for example, the Desert of Tschertschen. They have assumed the form of gigantic yellow waves, some 90 meters in height, with immense cascades of sand, all of a stereotyped monotony, on their leeward side. Approach them some still, bright winter's day. There they lie silent, still, and immovable. Not one particle of sand changes its position, not a sound disturbs the solemn silence, not a distant murmur reaches the ear. It is the realm of the stillness of death — indeed it would be impossible to imagine anywhere on the earth a more convincing picture of death and silence. And yet those lofty masses of sand are waves that are moving irresistibly forward and destroying everything in their path; and the reason they wear such a peaceful appearance at the moment when we approach them is that we have done so in an interval of rest, an interval that is a periodical episode in their ruthless westward march. These 90-meter high accumulations of dunes represent the sum of the activity of the wind during thousands upon thousands of years, the work of transportation which the east-north-east wind has been performing for countless ages, the result of an energy which has always been steadily directed towards one and the same common end. During the course of time millions upon millions of dunes have clambered up the windward side of the dune-accumulations and plunged over down their steep leeward side. However small may have been the contribution which each individual dune has made to the general augmentation of the mass, it has nevertheless been a plus, and all these contributions have successively built themselves up into the sandy mountains we see to-day.

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* If you compare Pl. 51 of vol. I with the photograph of a gale in the Mediterranean, made by Vaughan Cornish, and reproduced in *The Geogr. Journal* (May 1904), you cannot deny that the desert of sand-dunes is very like the open heavy sea during a gale. Most travellers who have visited real sand-deserts call attention to this likeness. Zittel, already cited by Baschin, calls a certain part of the Libyan Desert »ein einziges undurchdringliches Sandmeer«, and continues: »So weit das Auge reicht, folgt Dunenkette auf Dunenkette, alle entweder von Nord nach Sud oder von Nord-Nordwest nach Sud-Sudost streichend; die Zwischenräume sind mit Sand ausgefullt und gleichfalls mit niedrigen Hugelreihen bedeckt. Wie ein plotzlich erstarrtes vom Sturm aufgeregtes Meer liegt diese Sandmasse vor dem Beschauer, scheinbar fest und doch beweglich«. (*Pet. Mit.* 1874 p. 185). And Rolland has clothed the same impression in the following words, speaking of the Erg in the Sahara: »Le voyageur qui traverse une grande chaîne de dunes se croit au milieu d'un dédale inextricable; mais s'il gravit une cime élevée, il est dédommagé de ses fatigues par le spectacle grandiose auquel il assiste: les dunes qui l'entourent de toutes parts ressemblent, surtout quand elles sont bien orientées parallelement, aux lames de l'Océan, s'élevant les unes derrière les autres jusqu' aux limites de l'horizon. C'est comme une mer de sable, soulevée par un vent furieux, puis tout à coup solidifiée.« (*Géologie du Sahara Algérien*, p. 214.) The memorable journey of Gerhard Rohlfs' expedition in the Libyan Desert, from the description of which the above citation of Zittel's letter in *Pet. Mit.* is taken, reminds me in many respects of my own experiences in the Takla-makan and Tschertschen Deserts. For instance: »Am 6 Februar traten wir unseren Marsch an, täglich wurden etwa zwei oder drei Dunenketten in sehr spitzem Winkel uberschritten, wo sich gerade ein gunstiger Übergang darbot; in den sandigen Langsthalern fanden unsere Kameele so trefflichen Weg, dass wir jeden Tag ungefähr 36 bis 40 Kilometer in 9½ Stunden zurucklegen konnten. Unser 15 tägiger Marsch durch das grosse Libysche Sandmeer gehort sicherlich zu den eigenthumlichsten Reiseleistungen und war uberhaupt nur durch unsere eisernen Wasserkisten moglich . . . Unsere Wustenreise besass die grosste Ahnlichkeit mit einer Fahrt auf offener See; wie dort der Kapitan hauptsächlich nach Log und Peilung fahrt, so wurde unsere Karavane mittelst Kompasses gefuhrt . . . (*Pet. Mit.*, 1874, p. 185).

I have already briefly referred to the question as to why the northern and eastern parts of the Desert of Lop are free from drift-sand dunes. We must of course assume, that the prevailing east-north-east wind is in those parts at least equally laden with drift-sand as in the more westerly parts, where it does form dunes. Why are there not dunes then in every part of the desert alike? The reason cannot be the fact that the eastern part of the desert, in which schor predominates, is free from jardangs, which might arrest the sand; because in the vicinity of the bed of the Kuruk-darja and in the neighbourhood of Lôu-lan jardangs are especially numerous and well developed, and yet there are no dunes there. The answer to this question is to be found in the following words of Cornish, in which he discusses the origin of barkhans: »They form here and there upon the desert floor where the wind will let them. It appears that they neither occur in localities where the sheet of wind has everywhere the complete mastery over the sand, nor where the burden of the flying sand is everywhere too great for the carrying power of the wind: they dot the desert plain in localities where the sheet of wind has, for the most part, the mastery of the sand, but drops its burden here and there at certain points, or more probably along certain stripes. A rapid current of air can no more flow smoothly and with uniform strength over the ground than a rapid current of water can flow uniformly upon a rough channel or between winding banks. Wherever there are opposing lateral deflections, there is a double burden of sand, with a current relatively, perhaps absolutely, feebler, and here the sand drops. *

No matter how heavily the wind in the northern and eastern parts of the desert may be charged with sand, this never has an opportunity to remain, but is borne continually onwards. The rudimentary dunes that originate during the hours in which a storm is subsiding are in any case so small that they are destroyed by the next sand-storm that blows, and the sand of which they were composed is carried on farther by the atmospheric current. In the western part of the desert, where dunes exist, the circumstances are so far the reverse of this that the wind, no matter what its intrinsic force may be, is unable to sweep away continually all the sand that chances to be deposited there. In the extreme eastern dunes a sort of equilibrium is however regularly maintained. In that part we find small scattered dunes, very active, but temporary only in their existence, in that they are renewed almost *in toto* by every fresh storm. The power to form dunes is there exactly counterbalanced by the force of the wind. If on any occasion the wind is the stronger, then these extremely small dunes are destroyed: but if the power to form dunes is superior, then the wind is not strong enough to carry away the whole of the sand. And the farther we advance towards the west, the greater grows the superiority of the dune-forming power over the transporting power of the wind. Under existing circumstances, one might almost imagine a retro-active tendency, and that the increasingly higher dunes in the west affect the wind, influencing to some extent its force and its regularity. The more uneven the surface, the greater the friction of the atmospheric current against the earth; and the more its velocity is retarded, the greater is the quantity of sand that settles. In proportion as the dunes in the west increase in consequence of the continuous supply of fresh sand, the eastern edge of the desert ought to shoot out more and more to the east, and the first row of rudimentary dunes ought to progress increasingly farther in the same direction. On the other hand, if the western dunes were to be entirely removed, or the supply of drift-sand were to be either diminished or entirely cut off, the eastern edge of the sandy desert ought to recede towards the west. As a matter of fact it is the former process that really takes place, the reason being that the predominant east-north-east wind is less constant in the region west of the Desert of Tschertschen, so that the sand accumulates there to exceptional dimensions, and its retro-active effect upon the wind is intensified.

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* *Geog. Journ.*, March 1897. p. 290.

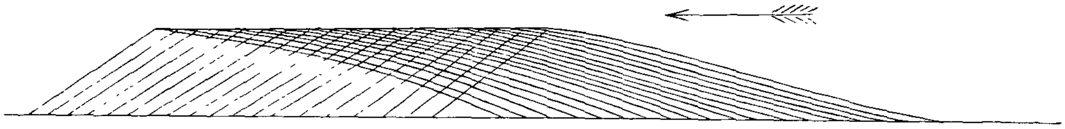


Fig. 194. A DUNE ADVANCING WITH THE SAME SPEED BECAUSE THE MASS REMAINS THE SAME ALL THE WAY.

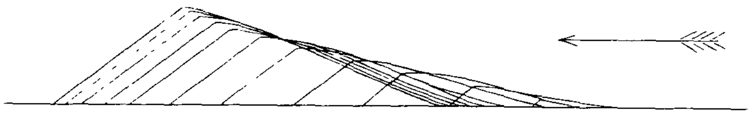


Fig. 195. A DUNE ADVANCING SLOWER AS THE MASS INCREASES.

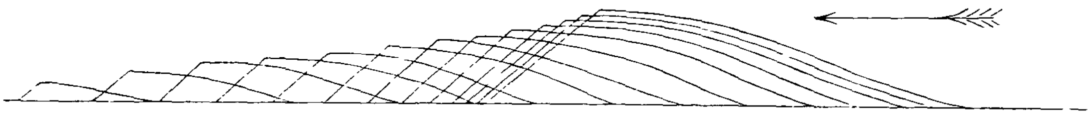
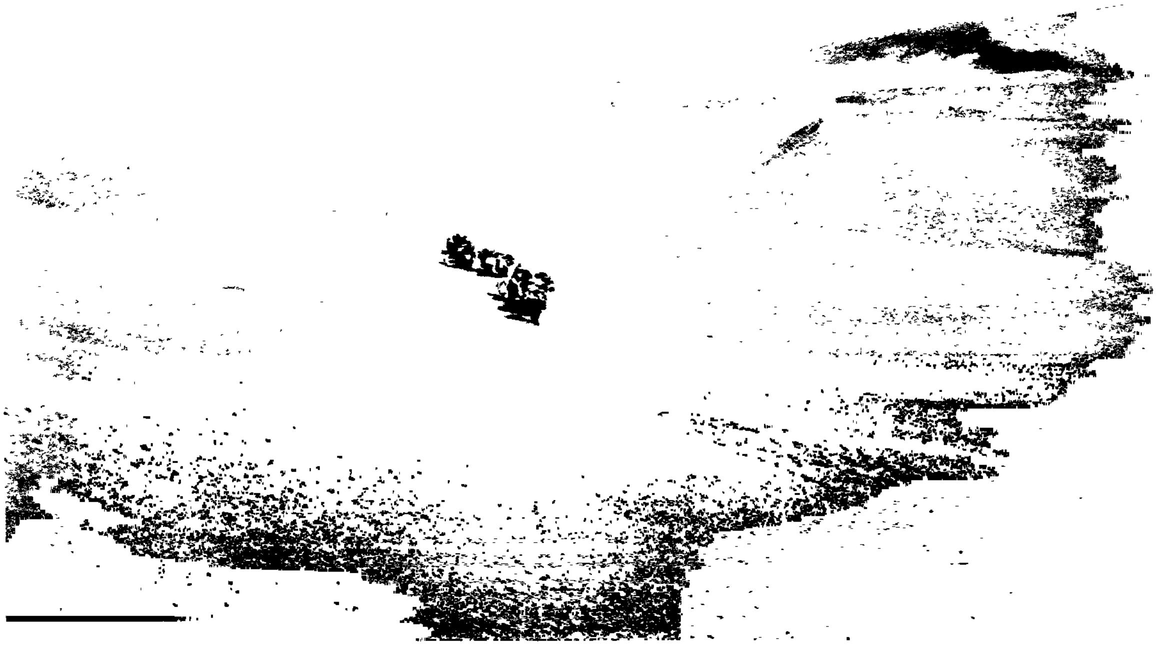


Fig. 196. A DUNE ADVANCING QUICKLY AS ITS MASS DECREASES.

If the clay under-surface of the Tarim basin were to be closely covered over with dunes one to two meters high and only linked together horizontally, though not in two storeys, then the line, for instance, from Jangi-köl to Tatran would for a certain time be crossed by even greater masses of sand than it is now, other circumstances remaining of course the same. The individual dunes I have supposed would gradually associate themselves together vertically also, and so form accumulations, and their rate of progress would decrease in porportion to the augmentation of mass. In this way increasingly greater quantities of sand would, during the same period, be held together, and so contribute to augment the size of the dunes. The same thing would also hold good for other meridional lines, situated east of that just named; and here again it would be possible to discern a retro-active effect upon the growth of the dunes, that is in the direction opposite to that of the prevailing



NORTHERN PART OF SANDY DESERT, 31ST JAN. 1901

Ljustr A B Lagrelius & Westphal.

MARCHING BETWEEN HIGH DUNES.

wind. Since we know that the rate of progress decreases with the mass, the dune-accumulations would, once they had attained pretty considerable dimensions, advance at such a slow rate as to amount to a condition of almost complete standstill. If however it really could be proved, that there is a definite limit to the altitude to which dunes were able to rise, but beyond which they cannot go, then the limit of progress, which approximates to standing still, would never be attained. And until the moment came at which the maximum altitude was reached, the advance would be at increasingly slower rates. Subsequently there would intervene a stadium of unchangeableness; for the volumes of sand which up to that point were employed in augmenting the dimensions of the dune-mass would then help to thrust it forward.

In some places therefore the sand that is carried along by the atmospheric current is deposited, in other places the sand that lies on the ground is blown away, the conditioning circumstances being the force of the wind, the eddies, the counter-currents, and the retardation of the lowermost stratum of the atmospheric current. The sand that is derived primarily from the Kuruk-tagh does not remain and form dunes immediately at the foot of those mountains, the reason being that the wind just there appears to be of maximal force. Add to this the selective power of the wind, dunes not forming until after the material has been sifted. It is only under especially favourable circumstances that the shape of the mountains, for instance a ravine or a projecting spur, is able to afford an opportunity for the accumulation of sand. Otherwise the masses of sand accumulate at a considerable distance from their source of origin. In this respect too the fine æolian dust is much more sensitive than the sand. In the Lop country the former only settles when the air is perfectly quiescent, but is instantly blown away again by the next wind. Far from contributing to the formation of loess deposits like those of China, the wind on the contrary scoops out the clay of the Desert of Lop, and so forms depressions. But while these in the Desert of Tschertschen travel with the same velocity that the dune-accumulations do, in the Desert of Lop they are stationary, and consequently after a certain time they fill with water. In the Desert of Lop the process of excavation proceeds at an incomparably faster rate than in the Desert of Tschertschen, partly because in the former the wind encounters no resistance whatever, and partly because it has also a species of abrasive or rasping material to help it, namely the sand. Yet, notwithstanding that the lofty dune-waves in the latter desert afford protection to the bajirs, the force of the wind is still strong enough to perform its excavating labour in spite of this, and that equally whether the deciding factor is the activity of the meridional winds, or of the cascade-like and eddying winds that pour over the dunes from the east. It was by means of this activity that I attempted to explain the origination of the bajirs. In some of these we found the ground moist right up to the surface, and against moist schor wind is powerless; and in that case the bajir depression has reached its maximum depth. Apart from this, there is nothing surprising in the wind now depositing dust and sand, and now carrying them away. That is precisely what happens in every river: in some of the quieter reaches the current forms alluvial sand-banks; in other places, where it runs strong, it excavates and erodes its bed.

What Walther calls by the native names of *takyr* and *schori* appear however to be something quite different from bajirs. He describes them thus: »Was uns die Takyrflächen im Grossen zeigen, das sehen wir an den turkmenischen Schori im Kleinen. Mitten zwischen den Sanddünen der Kara-kum sieht man oft langgestreckte oder rundliche Vertiefungen, die, von Lehmboden oder salzigen Wasser bedeckt, als ehemalige Flussbetten gedeutet und mit dem 'alten Oxuslauf' in Verbindung gebracht worden sind . . . Die Schori sind Vertiefungen zwischen den Dünen, in denen die gelegentlich fallenden Regenwasser sich sammeln, den von den Dünen herabgeschwemmten Thonstaub zu dünnen Thonschichten formen und mit ihren Salzen sogar kleine Salzschichten bilden können. Beim Weiterwandern der Dünen geraten diese Sedimente mitten zwischen die Sandablagerung, und erscheinen später auf dem Profil als thonige oder salzige Einlagerung. Während Takyr und Schori durch vorübergehende Regengüsse gebildet werden, sind die beständigen Wüstenseen in ganz ähnlicher Weise der Schauplatz einer grossartigen Sedimentation.»*

A SOLITARY TOGHRAK NORTH OF THE END OF THE KERIJA-DARJA.

It is quite natural that this difference should exist, because the shape of the dune-accumulations is, in consequence of the wind-relations, quite different in the Desert of Kara-kum from what it is in the Desert of Tschertschen. And it is precisely this orientation of the sand that gives direct occasion to the possibility of the origination of bajirs.

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* *Gesetz der Wüstenb.*, p. 112.

# CHAPTER XXX.

## ORIGIN OF SAND IN THE TARIM BASIN: DISINTEGRATION PRODUCTS.

I will now proceed to discuss briefly the sources of the immense masses of sand which have heaped themselves up in the basin of the Tarim. But let us first compare the views entertained by the three most distinguished Russian travellers who have written on this subject. Potanin says, that the barkhans in the eastern Ordos are formed by the red sandstone mountains of Schen-si and Kan-su. That portion of their sand which is derived from the alluvia of the Hwang-ho he regards as a minor by-product. He considers also, that the drift-sand field which accompanies the northern loop of the Hwang-ho, Kusuptschi and Tengeri, is a product of the northern slopes of the Nan-schan. The expanse of sand that lies north of In-schan appears on the other hand to owe its origin to the alluvial formations in the Desert of Gobi. According to Obrutscheff, the sand which now fills the old bed of the Hwang-ho is derived in part from central Mongolia, in part from the alluvia of the Yellow River, and in part from the disintegration products of the Chara-narin-ula.

On the other hand, Bogdanovitsch lays the greatest stress upon alluvial formations, and is so far forth at variance with the two explorers whom I have just named, in that they regard the encircling mountain-ranges as having been the principal sources of the drift-sand in the deserts below. It is the basin of the Tarim that he especially has in view. He says *inter alia:* »The fine argillaceous sand-deposits of fluviatile or lacustrine origin, which are left behind when the rivers change their beds, have afforded ample material for æolian formations . . . The gigantic sand-hills along the banks of the Jarkent-darja, between the Kara-koschun and Korla [i. e. our dune-accumulations in the north-eastern part of the Desert of Tschertschen], are built up of the disintegrated products of the fine-grained Jarkent clays . . . The atmospheric demolition of former fluviatile deposits already give occasion to the formation of continental sand-masses or barkhans.«*

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* *Loc. cit.*, above.

Before proceeding further, it will also be expedient to recall certain general principles. Walther enumerates the following six as the chief sources whence drift-sand formations are derived:

(1) Disintegrated sandstone;
(2) Immigrant oceanic (littoral) dunes;
(3) Wind-sifted fluviatile mud;
(4) Mud of inland lakes;
(5) Disintegration of quartziferous sediment;
(6) Mechanical disruption of coarse crystalline rocks.

But he adds, that there may conceivably be other sources. According to the same authority the desert sand in Arabia, South Africa, and Abyssinia is principally formed in the following way: »Granit, Gneiss, und ähnliche Felsarten, deren verschieden gefärbte Gemengteile eine verschiedene spezifische Wärme besitzen, unterliegen bei sehr heftigem und wiederholtem Temperaturwechsel einer Zerbröckelung in die einzelnen Mineralien. So bildet sich am Fuss der Granitgebirge ein grober Sand, der, vom Winde sortiert und abgeblasen, endlich in einen reinen Quartzsand verwandelt wird.»* Further: »Der Dünensand ist durch Windselektion aus einem thonhaltigen und sandigen Verwitterungsgrus entstanden, und wenn auch die Hauptmenge der thonigen Verunreinigungen daraus entfernt sind, so ist doch immer noch eine gewisse Menge Thonstaub in dem Dünensand enthalten . . .»**

The drift-sand itself then acts in a secondary manner as an abrading material upon both the coarser and finer products of disintegration. Of the latter we encountered examples in the Desert of Lop; while, as Walther says, instances of the former exist everywhere in deserts: »In der langen Trockenzeit ist die Ebene und alle auf ihr liegenden Steine ein Spiel der Deflation und des Sandtreibens, und so verschwinden allmählich die Spuren der Erosion.»

»Überall in der Wüste zu beobachten, aber in ihrer denudierenden Wirkung stark überschätzt, ist die schleifende Thätigkeit der windgetragenen Sandkörner eine charakteristische Begleiterscheinung der Deflation, und jeder Dreikanter beweist, dass der Wind trockene Sandkörner aufgehoben und verfrachtet hat.»***

The dunes which are met with in a mountainous desert show, according to Walther, by the properties of their sand that they cannot have been transported from any great distance, but had their origin in the dissolution of rocks in the vicinity. He is of opinion, that one of the principal, if not indeed absolutely the principal, source of desert-sand is the crystalline rocks, granite and gneiss.

With regard to the atmospheric material of the steppes, Richthofen says, that it is manifestly derived from the surface already deposited, and that the process which is now taking place is merely a re-deposition; but every time it is re-deposited there is always found an intermingling of material derived directly from a rock source. He says: »Es kann keinem Zweifel unterliegen, dass alle Teilchen ursprünglich dieser Quelle entstammen . . . Denselben Saigerungsprozess wie das fliessende Wasser führt der Wind aus; aber sein Bett ist breiter und unbestimmter als das der

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* *Gesetz der Wüstenbildung*, p. 30.
** Id., p. 127.
*** *Op. cit.*, pp. 101 and 51.

Flüsse. Wo immer er den Steppenboden aufwirbelt, scheidet er die Bestandteile nach ihrer Grösse, und bewegt sie mit verschiedener Geschwindigkeit vorwärts. Die leichten thonigen Substanzen werden schnell als Wolken über Länder getragen und bleiben selbst bei ruhiger Luft noch schwebend, gerade wie wenn sie durch Flüsse in ein stilles Seebecken gelangen. Als eine langsame, furchtbare Flut wälzt sich der Sand nach bestimmten Richtungen fort, und indem er immer wieder auf's neue umgekehrt und durchgeblasen wird, verliert er das letzte thonige Teilchen, das vielleicht noch nach einem Regenfall ein Samenkorn zum Sprossen zu bringen vermocht hätte. Selbst aller Vegetation bar, überzieht er auch diejenigen Stellen, wo der fruchtbare Lössboden eine Pflanzendecke trägt, und so kann aus kleinen Anfängen die Sandwüste fortwachsen . . . Bei weitem die grösste Verbreitung hat der Sand in den einzelnen sehr weiten Becken, in welche der Boden des Han-hai geteilt ist. Hier entstammt er zum grossen Teil den Kreidesandsteinen, deren Zerstörungsprodukte der Wind zusammengeweht und von ihren nach Stoliczka's Beobachtungen bedeutenden thonigen Beimengungen gereinigt hat.»*

Loczy, speaking of the drift-sand dunes which rise on the shores of the Lake of Po-jang and beside the Jang-tse-kiang near the frontier of Ngan-hwei, all situated at a considerable altitude above the river, says, that he was unable to form any decided opinion with regard to them. «Es scheint selbst jene Annahme nicht ausgeschlossen, der zufolge der Flugsand aus der Verwitterung jenes jung-paläozoischen oder alt-mesozoischen roten Sandsteines hervorgegangen wäre, welcher im Inneren der Provinz im Gebiete der paläozoischen sinischen Gebirgsketten eine so grosse Verbreitung besitzt. Schliesslich könnte auch der Umstand als eine wahrscheinliche Erklärung des Auftretens von Flugsand dienen, dass die Hochwässer des Kan-kiang im Verlaufe des Sommers den Sand aus dem verwitterten Grus der roten Sandsteinhügel mit sich herabführen, dass dann, während der trockenen Wintermonate, wenn der Wasserstand des Sees ein kleiner ist, grosse mit Sand bedeckte Flächen des Seebodens trockengelegt werden, von welchen die Winde den Sand auf die Ufer hinaufwirbeln. — Es könnte daher auch der Process der gewöhnlichen 'Dünenbildung' den am See befindlichen Flugsand erzeugt haben. Diese letztere Erklärung scheint mir im Vereine mit der Annahme einer relativen Hebung der Umgebung des Sees während der Jetztzeit die am meisten annehmbarste zur Entstehung der stellenweise selbst 100 Mtr. hohen Flugsandhügel an den Ufern des Po-jang-Sees zu sein.»**

Loczy is here upholding the same opinion as Bogdanovitsch, that the drift-sand owes its origin for the most part to alluvial and sedimentary deposits, that is to say, it has passed through an intermediate stage, having been re-deposited in water previous to falling into the power of the wind; in a word, that it is not derived directly from the rocks. He pronounces, that the sand of the Desert of Gobi, which now fills the basin of Kan-su, has various sources of origin. As a rule, it is the finer and smaller particles of the stony desert that provide the material of which dunes are built up; for the same varieties of rock and minerals that exist in the stony desert are found again in the sand. The sand-particles are much rounded, and they are remarkably pure, argillaceous matters being nearly always absent. But the formation of sand is also promoted by fluviatile mud. The San-ta-ho and the Su-la-ho both deposit arenaceous mud during their high-water period.

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* *China*, I, pp. 98—99.

** *Die wissenschaftlichen Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, 1877—80*, I, p. 369.

»In der Gegend von An-si-fan befindet sich nun das vielfach verzweigte Kanalnetz zur Bewässerung gerade im Sande des Inundationsgebietes und entlang dieser Kanäle sehen wir die bei Reinigung derselben hoch aufgeworfenen Sanddämme, die dann später von den Winden so energisch angegriffen werden, dass die Landleute sich von den schädlichen Sandwehen durch Baumpflanzungen nicht genug schützen können.»*

Finally he mentions a carboniferous sandstone and a conglomerate in certain districts that furnish a third variety of drift-sand.

The truth is, that the drift-sand in different parts of a large basin are derived from different sources, and under the influence of the wind the various products blend together in the marginal regions into a more or less homogeneous substance. On the other hand it is doubtful how far the two small streams named above are powerful enough to form sand in the way suggested. If that were so, then a powerful stream like the Amu-darja ought to produce dunes of colossal dimensions, whereas the dunes it does form cannot be compared with the dunes that exist in other regions of Central Asia. The geographical distribution of the Transcaspian sandy deserts suggests the erroneous view that they are connected with the rivers. The sands there are travelling southwards at the rate of 6 m. a year, and the Amu-darja at the rate of 50 m. in the year, towards the north-east; hence it is not surprising to find the Desert of Kara-kum on the south-west of the river. Pretty much the same relations obtain in the case of the adjacent Sir-darja, which likewise has a sandy desert to the south-west of it, namely the Kisil-kum. Still farther to the north-east we have the river Tschu, and south-west of it is the smaller desert of Ak-kum. Thus there obtains, it is evident, a physico-geographical law, to the effect that each river appears to give rise to its own sandy desert. Now the rivers which Walther quotes as presenting the most striking exemplifications of the power of fluvial dune-formation are the Amu-darja and the Sir-darja, for both of them bring down enormous quantities of sand from the regions in which they have their sources. »Von März bis Juli steigt das Wasser um 3 m. und überschwemmt weithin das Ufer, um seinen grauen sandigen Schlamm darüber hinzubreiten. Sobald das Wasser des Jaxartes fällt, trocknet der heftige heisse Nordwind die Uferebene und bläst allen Staub und alle Schlammteilchen davon. Den übrig bleibenden, gereinigten Sand aber schüttet der Wind zu Dünen auf, und aus dem Ufergelände steigt die Sandwüste Kysyl-kum hervor.»**

Upon reaching the right bank of the Amu-darja the dunes of the Kisil-kum plunge into the river, and reappear a short distance lower down as alluvial formations under the left bank. Did the river not exist, there would be nothing to prevent the dunes from travelling on without interruption; but since the river does exist, there results a break in the continuous advance of the dunes, in that the sand is re-deposited after the dunes are violently broken down; yet they are soon re-created in the Kara-kum, and upon reaching the shore of the Caspian they coalesce with the high coast-dunes which already exist there. Walther offers a remarkable proof of how these æolian transgressive masses of sand are giving rise under our very eyes to a new sandstone formation, which is spreading out over the bottom of the former Aralo-Caspian Sea and the Sarmatic sea of the Miocene era; the sandy desert growing in area in proportion as that sea continues to shrink.

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* *Op. cit.*, p. 521.

** *Gesetz der Wüstenbildung*, p. 119.

Walther maintains therefore, that the Kisil-kum and the Kara-kum have been formed by the sand brought down by the rivers. But is it indeed possible that any rivers could give rise to sandy deserts of such immense extent as these? For my own part I cannot believe it. The two rivers in question are not sufficient to explain the origin of this desert zone; that would on the contrary exist even though there were no rivers. I do not of course mean to assert that the areniferous muds of the rivers do not make any contribution to the sandy desert; yet they do it to what is relatively so insignificant a degree, that in all probability the character of the sandy desert would be but very slightly altered even if this fluviatile supply were to be entirely cut off. The belts of sand which are formed by the side of the great rivers of Russia are infinitesimally small as compared with the Kisil-kum and the Kara-kum. Possibly this difference is to be attributed to the fact that they bring down smaller quantities of sediment and sand, and come from low-lying mountainous regions. Nevertheless I believe that the key to the puzzle is to be found in the fact, that no river, however big and powerful, can under any circumstances give rise to a great sandy desert. Consequently wherever we find a desert of this character beside a river, as, for instance, the Amu-darja, other and more powerful agencies are there operative, and it is purely an accident that the river makes its way through the desert, the dunes of which it certainly does help to augment, though it does so entirely in a secondary way. In this case, owing to the local conditions, the direction of the wind, and the shifting of its bed by the river, the river offers no insuperable impediment to the progress of the dunes. The sand cannot be destroyed, it is only disturbed for a certain time. But in the case of the lower Tarim, between Arghan and Tschigelik-uj, the circumstances are quite different; for there the river has been for several years stationary, so that the west bank has been swept clean of sand; hence the river there *is* an obstacle to the farther advance of the dunes.

Yes, even though the Amu-darja and the Sir-darja did not exist, there would nevertheless be a sandy desert there, because the climatic and other conditions are favourable to the origination of a desert. These conditions, the presence of sand on the surface of the ground coincidently with a very dry climate, are absent in the basins of the rivers of South Russia, and consequently the formation of dunes is dependent solely upon these rivers' power to form them; as a result of this the dunes there occupy but narrow strips. When the two principal conditions are present, the absence of the third, namely the river, is of less consequence. For example, in several places beside the Caspian Sea and the Sea of Aral there are extensive patches of sandy desert where rivers are entirely wanting. Walther says: »Eine weitere Quelle des Wüstensandes sind der Boden und die Küsten von Seen mit wechselndem Wasserstand und der Boden von Trockenseen. Sanddünen werden von den Ufern des Aralsees beschrieben, und an den Ufern des Caspi spielen sie eine grosse Rolle.»[*] In 1893 I travelled, at the north-east corner of the Sea of Aral, through a zone of shore dunes of very respectable dimensions.[**]

It is precisely because the deserts we are discussing extend regionally over such wide areas, and because certain parts of them, as for instance on Mangischlak, are so far distant from all rivers, that they appear to be more intimately connected with the shrinking of the Aralo-Caspian Sea than with the great rivers. I have however no intention of denying to the rivers the dune-forming power that really does belong to them. Beside the middle Dnjepr the fluviatile dunes reach the height of 12 m., and beside the Don they vary from a few decimeters up to 10 m. and more. This belt of dunes, between Ust-Medveditskaja and Novo-Grigorievskaja average 12 to 13 km. in breadth. Sokolow says with regard to this belt of sand-dunes: »Die Entstehung der dem Don am nächsten gelegenen Dünen aus dem vom Don abgelagerten Sande ist wohl kaum zu bestreiten; nicht so leicht ist aber der Ursprung der zweiten an beiden Seiten des Atschardàbaches sich ausbreitenden Flugsandzone zu erklären. Ihn dem Bache selbst zuzuschreiben, wäre wenig begründet, wegen der in keinem Verhältnis zu einem unbedeutenden Bache stehenden mächtigen Sandabsätze.»[***] And he goes on to prove that the belt of sand in question is a survival from an old bed of the Don. Sokolow also clearly assumes, that the dunes beside the Bay of Narva and on the southern side of the Gulf of Riga are formed exclusively out of the sand which the rivers Narva and Düna (Dwina) have brought down to the sea, and which the sea has subsequently flung back upon the coast. In a word, the dune-forming power of rivers is proved to exist beyond all doubt. All I desire to say is, that to this power there exists a limit. If the belts of fluviatile dunes to which I have here briefly alluded, or those which have been formed in the deltaic regions of many other much greater rivers, be compared with continental dunes of the type which occurs, for instance, in the Tarim basin, it is abundantly evident that the latter could not be formed in the same way. In the case of the former we *know* that the several rivers in question are the causes of their origination; but in the case of the latter it is impossible to prove that the adjacent river, *i. e.* the Tarim, is the source and origin of the dunes which abut upon it. There exists no plausible reason for agreeing with Bogdanovitsch, when he says, that these last are formed out of former fluviatile and lacustrine deposits, and that the gigantic dune-accumulations between Karaul and Kara-koschun consist of products derived from the disintegration of the Jarkent clays. If the origination of this desert cannot be accounted for except in dependence upon the vicinity of the river, how are we to explain the formation of the adjacent deserts, where there does not exist the smallest river, and scarce any trace even of older river-beds? The Kum-tagh of Pitschan cannot be regarded as having been originated by the extremely insignificant stream which exists there any more than the southern Kum-tagh can be traced to the effects of the small ephemeral streams that issue from the Astin-tagh, and which, at the period of high-water alone, advance only a few kilometers

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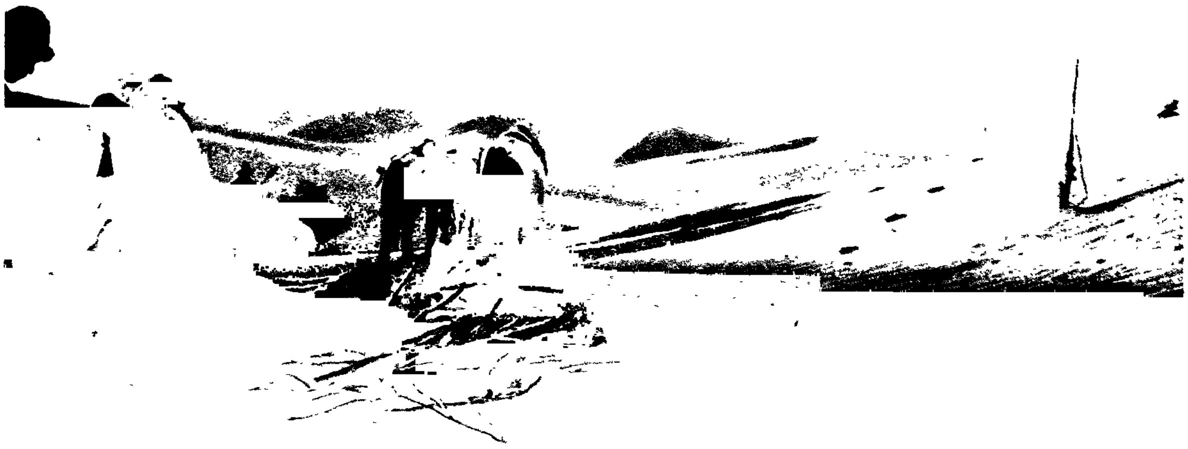
[*] *Gesetz der Wüstenbildung*, p. 119.

[**] *Through Asia*, I. p. 48.

[***] *Die Dunen*, p. 250.

Pl. 50. a.



Ljustr. A. B. Lagrelius & Westphal.

VIEWS FROM DESERT OF GOBI.

beyond the ends of their valleys. And even greater appear to me to be the difficulties of establishing any sort of a connection between the immense, sharply bounded zone of sand that lies south of the Basch-kum-köl and fluviatile activity of any description, for there is no river at all there, only a brook, fed by springs and flowing solely through marshes. I am utterly unable to persuade myself, that this broad belt of sand can have anything whatever to do with the adjacent lake; any more than I can conceive it to have been originated in the same way as the area of sand which Loczy describes as existing beside the lake of Po-jang. Here it is solely and alone the regular winds that have heaped up the sand in a given locality, where the atmospheric current either has greater friction to overcome, or forms an eddy, or encounters some other current of the atmosphere — where, in a word, it is somehow arrested.

Potanin and Obrutscheff appear to me to be perfectly right when they look to the permanent solid rocks in the neighbourhood as the direct source of the drift-sand. The fact that such sandy deserts as the Takla-makan, the two Kum-taghs, the Ak-bel-kum, and several others are situated in oval-shaped basins explains how, e. g. the first-named and the last-named come to have a river for their neighbour. All the same the propinquity is accidental: it is just as natural for the sand to remain in a depression as it is for water to flow towards the lowest part of its basin. It is just as easy to mention instances of basins with a river but no sand as it is to mention a basin with sand but no river. When we find both present in one and the same basin, it means that the conditions have been equally favourable to them both. Masses of sand are however more independent of the shape of the basin than water is, and in so far as the direction of their progress is concerned, they are, for reasons that will be readily understood, more independent of the laws of gravity, because they are able to climb up a slope just as easily as they glide down it. In the eastern Takla-makan and the southern Kum-tagh, for instance, the dunes proceed from lower to higher ground. In some of the Central Asian deserts, for instance the Kisil-kum and the Kara-kum, it is scarcely appropriate to speak of a basin; at any rate they fill each such a small portion of a basin that within their own precincts the special characteristics of a basin are lost. As a rule it may however be said, that sandy deserts are more or less distinctly confined to basins and depressions; indeed this is implicate as an axiom in the laws of gravity, because both aqueous and atmospheric currents alike, when they level down the surface of the earth, wear down all the elevations and fill up all the depressions.

Let me now attempt to answer the question with which I began this present discussion — where do the masses of sand come from that fill the basin of the Tarim? I hasten to observe however, that this problem is so complicated, and several factors which have to be taken into account are so uncertain, that it is impossible to arrive at anything like a sure and certain result. For the most part we have to rest contented with nothing better than guesses and suppositions. One source of great uncertainty is the circumstance, that the climate, during the vast periods which have elapsed since the Central Asian »Mediterranean» disappeared, must itself have undergone great changes. When that vast inland sea existed, the atmosphere must obviously have possessed higher hygroscopic properties than it possesses now, and the rivers must have carried incomparably greater volumes than they do now, and consequently their power of transporting solid materials towards the central parts of the basin, that is into that ancient Mediterranean, must have been in a corresponding degree greater. On the other hand, the wind's power of transporting the products of disintegration must have been far less. Owing to the proximity of that sea, the differences of temperature cannot have shown such continental extremes as obtain there at the present time. The greater amount of moisture in the air and the more plentiful supplies of water would nourish a richer vegetation; and by this means the products of disintegration would be more abundantly arrested, extracted from the winds, and retained. How far the disappearance of that great inland sea was a consequence of the inception of a more arid climatic period, or whether the relation of cause and effect was *vice versa*, I will not venture to discuss. It is sufficient that the two phenomena were coexistent, and the very first diminution in the area of the sea would be the signal for the sandy deserts to begin to form.

If now we fix our thoughts upon the processes which must anciently have taken place along the lines I have just indicated, and direct our attention to the aspect which that region presents at the present time, we may by way of a beginning answer the question I have posited in the following manner: the masses of sand which at the present time fill the basin of the Tarim were originally derived from the mountain-ranges which encircle that basin. Proceeding one step farther, I would add, that those masses of sand are derived from three separate sources, in part directly, in part indirectly: (1) the direct transportation by the wind of the products of disintegration from the adjacent mountains, whether sandstones or crystalline rocks; (2) through the activity of the wind operative amongst the arenaceous alluvia of the rivers and temporary lakes; (3) through the sand that was already present in the soil, and which became exposed in rings more or less concentric in proportion as the former sea dried up.

Of these three factors Bogdanovitsch looks upon the second as being the most important, indeed the only valid one, and, as we have seen, Walther agrees in so far as the Aralo-Caspian basin is concerned. In this basin there exist two rivers, each possessing a considerably greater volume of water than the Tarim, and consequently a much greater power of transporting silt and sand to the lowlands. Even without the help of arithmetical data, it is easy to see, as I have myself seen, that at the period of high water the Amu-darja and the Sir-darja carry incomparably greater quantities of sediment than the Tarim does. Further, the catchment-area of the Tarim is smaller than the desert that the river flows through without receiving any affluent. The catchment-area of the Amu-darja and Sir-darja is more than twice as extensive as that of the Tarim, and at the least equal to that part of the desert which this last subsequently flows through, and which is all that we are here called upon to consider. If now it is the river which in each of these cases has given occasion to the origination of the sandy desert, then the Amu-darja and Sir-darja, having a much wider catchment-area and a more plentiful supply of material to operate with, ought to have created a much more extensive desert than the Tarim has done. In reality however the opposite of this has taken place;

for in respect not only of the altitude of its dunes but also of the unbroken continuity of its sand, the desert of the Tarim exceeds both the Kara-kum and the Kisil-kum. Nor can we attribute this entirely to the total disappearance of the internal Central Asian sea, while of the Aralo-Caspian sea there still survive two large lacustrine basins, so that this last has not proceeded so far in its negative development as the former. In a word, if we look upon the river as the agent of the formation of the desert — always assuming of course that the climatic conditions really allow it — then we are absolutely unable to answer the question, why a certain river should have produced a larger desert than two other rivers, each of which is in itself more powerful than the first-named, while both have yet co-operated together to give origin to one and the same desert.

As regards more particularly the Tarim, those parts of its system which possess the largest volumes of water, i. e. the region of the lower Ak-su-darja and the region of the lower Jarkent-darja as far down as Maral-baschi, are practically nearly free from sand. At any rate the sandy desert is there far less developed than in other parts of the river-system. Beside the lower Jarkent-darja the high sand is everywhere one or two days' journey distant from the river. If it be objected, that this affords no proof, because the river may there have altered its bed, I would beg to point out, that those are the regions, nearest to the outside boundary of the catchment-basin, in which changes of bed are at a minimum. Wherever the sandy desert thrusts out promontories, small dunes, right up to the river, it is not the river to which these last owe their origin, but it is the dunes which, driven forward by the wind, threaten to smother the forest. The Chotan-darja, which is now dwindling rapidly, is on the contrary embedded amongst dunes, and the Kerija-darja, which was once an affluent of the Tarim, is being rapidly destroyed in its futile struggle against the drift-sand. But surely nobody will venture to maintain, that these two rivers, in former times when they carried more copious volumes, deposited all the sand which is now destroying them. Why, all the space that intervenes between the Jarkent-darja and the Chotan-darja, and that between the last-named and the Kerija-darja, are filled with dunes, much loftier than those that lie adjacent to the rivers themselves. And in the case of fluviatile dunes, it appears to be characteristic, that, unless the river alters its channel, they are wont to persist at any rate somewhere near to the river to which they owe their origin.

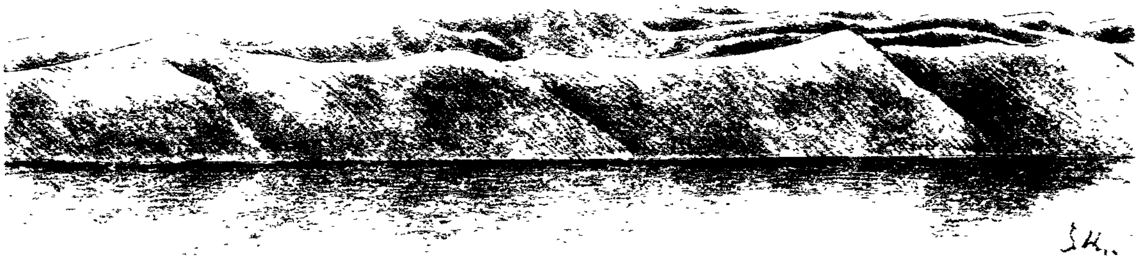
Let us now consider the middle portion of the Tarim proper, e. g. the region around Tschimen — there we find that the river is indeed divided into several arms, of which only one as a rule carries water, the others being dry and abandoned. The country between these arms is practically quite free from dunes, and the plentiful vegetation — woods and kamisch, steppe and bushes — which springs up beside every newly formed river-bed renders the formation of dunes impossible, while any alluvial sand there may happen to be is bound fast by the vegetation, and thus the activity of the wind is rendered powerless. If there really were any appreciable formation of dunes taking place in that part of the river's course, one would expect to find at least rudimentary dunes along the banks; but it is precisely in that quarter that there are none.

Let us now proceed lower down to the reaches between Karaul and Arghan, to which Bogdanovitsch especially calls attention. I opine that a glance at Pll. 24, 32

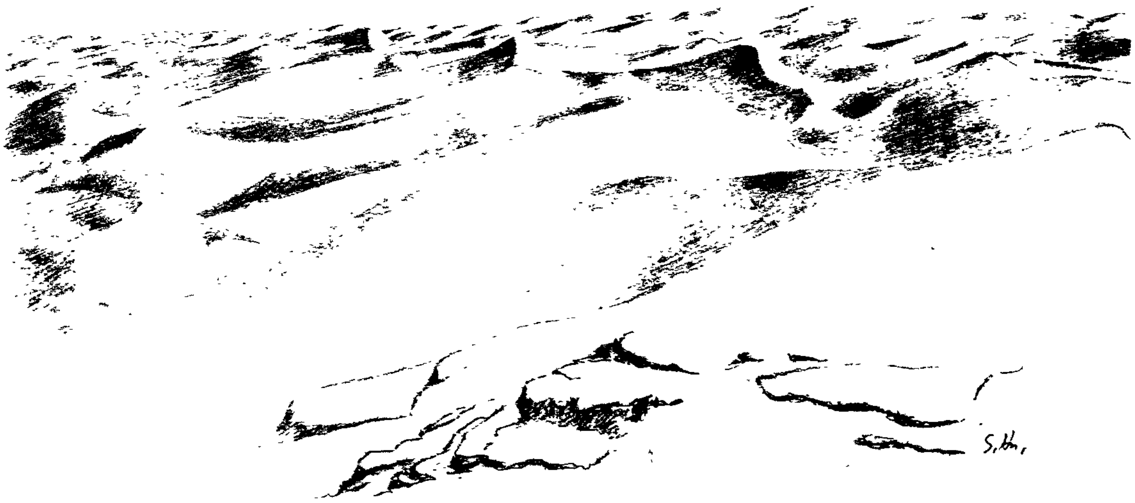
33, 34, and 38 of vol. I will be sufficient to convince the reader, that those 90 m. high dunes do not owe their origin to the river. On the contrary, the river is engaged in an instant desperate struggle for existence against them. But might it not be, that the river formed them during the period in which it flowed eastwards into the Lop-nor; that the prevailing wind subsequently blew them towards the west-south-west; and that the Tarim, after assuming its present course, overtook them, and then began to annihilate its former creation? No, for if so, it becomes absolutely impossible to explain, why it is that the highest dunes in all the desert happen to exist just in those parts of the river's course in which the volume has decreased by one-fourth or one-fifth of what it is at the mouth of the Ak-su-darja (at high-water period), and in which consequently the fall, the velocity, and the power to transport sand and silt are incomparably less than they are at the mouth of the Ak-su-darja. The masses of sand which the river does transport from the mountains are deposited not far below the last-named position — the sedimentation being evident from the shape of the river-bed, its breadth, and the extent of its alluvia. The sand which occurs lower down in the bed of the river is derived partly from these same alluvial deposits, and in this way advances step by step down the stream; but the greater part of it is filched from the dunes that overhang the river, and is deposited again very near to the place whence it is obtained. Moreover the quantity of sediment from the mountains of the Jarkent-darja, which travels down as far as the delta of the Tarim and its terminal lakes, is exceedingly small. A much greater quantity is derived from the mountains of the Ak-su-darja; but the greatest amount of all is picked up by the current, on its way down, from the river-bed itself, from the containing banks, and generally from those parts of the course in which its current is most active. If we consider the Jarkent-darja alone, we notice how rapidly its power of transportation decreases as it approaches the mouth of the Ak-su-darja. On 23rd September 1895 I crossed the deep valley (*thalweg*) of the river at Tong: immense masses of water were still rolling on, between banks that were often vertical; the level was however already 3½ m. lower than it is during the summer; the water was only semi-transparent; and it would have been able to move pretty large pieces of rock with ease. The finest gravel that the river is able to displace does not travel farther down than to Jarkent, and at Lajlik the bed is composed entirely of soft material, including a large quantity of sand, the consequence being that the river there is broad and has an abundance of alluvia. How far the river is able to transport sand of the ordinary size, 0.1 to 0.3 mm., it is difficult to say, though the distance varies of course according to the season, that is to say with the volume. The shape of the river-bed in the tracts above the mouth of the Ak-su-darja makes it probable, that virtually no sand is deposited so far down as that; at any rate in the autumn the water there was especially clear, and the current so sluggish that even the finest particles of sand (0.05 mm.) would very soon have settled to the bottom.

Finally, I may adduce yet one other argument that weighs in the balance for the view I am upholding, namely that the contribution which the river makes to the formation of the sandy desert is extremely small in comparison with the other two factors I have mentioned above. Even though we did admit that the gigantic masses of sand in the Desert of Tschertschen owed their origin to the river, we

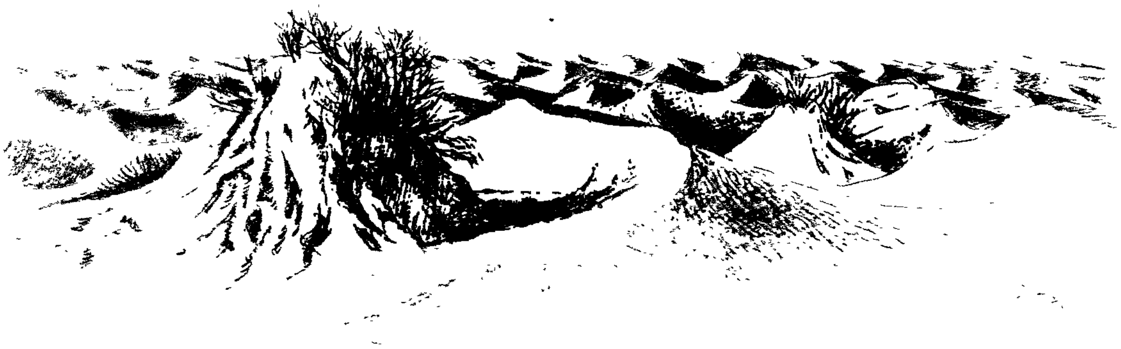
Pl. 50. b.



DUNES ON THE EASTERN SHORE OF NIAS-KÖL.



DUNES IN THE HEART OF THE TAKLA-MAKAN DESERT.



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DUNES IN THE KERIJA DESERT.

are not at all on that account warranted in maintaining, that the dunes of the western Desert of Lop are formed in the same way, because they lie directly to the windward of the existing river-system, and are travelling in across it, in the same way as the dunes of the Kisil-kum are travelling over the Amu-darja. Bogdanovitsch is undoubtedly to a certain extent right, when he states, that the dunes owe their origin to lacustrine and fluviatile deposits of former ages that are now exposed to the wind. For this east-north-east wind sweeps right over the dry beds of the Kuruk-darja and the Lop-nor, and in the latter we have ascertained in especial that the wind is excavating it and making the depression deeper. In so doing it liberates not only dust, but also sandy material, which, upon being swept on farther towards the west-south-west, helps to augment the dunes in the Desert of Lop. But where has the sand come from which thus lay embedded in the sedimentary deposits of the Lop-nor? Well, part was carried there by the river, provided of course that the river washed, as it does now, the western front of the desert dunes; but by far the greatest part was carried there by the wind, as it swept across the lake charged with the products of disintegration. These, instead of being transported farther to the west, were arrested by the lake and its kamisch, and consequently they have simply passed through a stadium of rest, for they are now being removed from the desiccated lake-basin and transported farther. In part therefore the sand in that region has performed a species of revolution, and in part it has been arrested by the lake whilst on its way from its primitive source of origin, the solid rocks.

And, as I have already proved, precisely the same part is now being played by the Kara-koschun, in that it engulfs enormous quantities of drift-sand which enter it from the east, and which will only reappear and be re-excavated when the lake has completely dried up. If the region from Karaul downwards be taken into account, then a certain modicum of sand is even now describing a sort of revolution. In the delta there are undoubtedly arms beside which fluviatile dunes could arise, because the former have occupied their present positions too short a time for vegetation to have sprung up beside them, and when the beds dry up their sediments fall a prey to the wind. But the material of these alluvial formations is derived in great part from the continental dunes which overhang the river higher up, and from the bases of which it has been washed down by the current. Hence it is not these minimal fluviatile dunes which in the process of time have given rise to the continental dunes, but it is these last which, with the help of the river, have given origin to the fluviatile dunes, which are afterwards swallowed up by the big dunes: the augmentation of mass they effect is therefore = ± o.

# CHAPTER XXXI.

## ORIGIN OF SAND IN THE TARIM BASIN: ALLUVIAL SAND AND ALREADY EXISTENT MARINE SAND.

Let us now proceed to consider the first of the three original sources of the sand which I have mentioned above, namely the power which the wind possesses, through selection and transportation, of collecting it and building it up into dunes. We have *a priori* to regard all the sand in the basin of the Tarim as having been derived originally from the encircling mountainous tracts. What now is the relation that exists between the volume of the masses of sand and the effects actually produced in those mountains by the agency of deflation and erosion? To this question I will make a feeble attempt to furnish some sort of an answer, though I hasten to add, that my figures must at the best be regarded as approximate only. The area of the lowlands in the basin of the Tarim amounts to 470,000 square kilometers. I assume that of this about 370,000 square kilometers are covered with drift-sand. When describing the Desert of Tschertschen, I assumed that two-thirds of its area were sand, and the remaining third bajir; and as in the western half of the Takla-makan bajir depressions are either non-existent or extremely rare, we may estimate the area of sand-covered ground at 300,000 square kilometers. Suppose that the dunes, or rather the accumulations of dunes, throughout the whole of the region have a mean altitude of 50 m., we then have a volume of sand amounting to 3,750,000,000,000 cubic meters, or say, for the sake of simplification, four billion cubic meters = 4,000 cubic kilometers of sand. This amount would correspond to a mountain range 400 kilometers long, 100 kilometers broad, and 100 meters mean altitude, dimensions considerably smaller than the eastern part of the Kuruk-tagh system, which, as it is, is already extremely small. The sandy material that we now find in the desert has been transported to the lower parts of the basin by the conjoint activity of winds and water. Hence it has been derived in part from the entire catchment-basin of the Tarim, the area of which amounts to 414,000 sq. km., as also, over and above that, from the region lying east-north-east of the Tarim basin that is dominated by the east-north-east wind. How great this last-named region is it is impossible to say. Let us assume however that the area of the entire region which has yielded its tribute to the sandy desert is, in round numbers, 800,000 sq. km.

It would require a layer, spread out over the whole of this area, of 5 m. in thickness, or rather less owing to its varying degrees of compactness, before the 4000 cub. km. of sand we have estimated to exist in the desert would be accumulated. One factor which does not enter at all into this calculation is the fine drift-dust, which for the most part settles in quite other regions than the drift-sand, after being sifted out from this latter by the wind. The amounts at which we have thus arrived are *per se* stupendous. The masses of sand in the Takla-makan would indeed form a ring all round the earth, or a wall of sand built all along the equator, one kilometer in breadth and one hundred meters high!

And yet the loss which the mountain girdle has thus suffered ought not to have altered its character to any noticeable extent. The elevations and valleys will still occupy the same position and present the same appearance, and the human eye would never suspect how great is the transportation of material that has taken place. If two maps could be drawn of those peripheral regions — peripheral, that is, to the catchment-basin of the Tarim — one before, and the other after, the transportation, and drawn with perfect accuracy, they would nevertheless be exactly alike, for the changes of level would not admit of being detected by ordinary instruments, unless it were a finely graded theodolite. When we remember how slowly denudation proceeds and disintegration becomes perceptible in relation, not to the average span of human life, but to the interval of historic time, we literally stand aghast when we endeavour to form a conception of the enormous period that has been necessary to effect a denudation over the area in question to the extent of 5 m. in depth. For the transportation of solid material from the highlands to the depressions and the basin proper also went on of course at a very lively rate even during the time that the Tarim basin was filled with water, though the main operative agency was then erosion.

After the great inland sea dried up and the climate became more arid, in other words in the period that is now elapsing, it has been, I am convinced, the wind which has been mainly operative in increasing the amount of the sand and in extending the sandy desert far beyond its older limits. Such a statement does not admit however of being proved with figures. But if, as I have endeavoured to show, the rivers at the present time not only carry too small a volume of water, but also move too slowly, to transport any noticeable amount of sand to the eastern parts of the basin, then the wind is the only force that does possess sufficient power to make an increase in the already existing quantities of sand. But that it must be increased is almost a matter of natural necessity, because it was precisely the general and steadily growing aridity of the climate which established the conditions for the origination of the sandy desert. Nobody who has had personal experience of the spring storms that blow along the southern foot of the Kuruk-tagh can any longer be in doubt as to the rôle which the wind plays. Suppose your tent is standing in a bare, open part of the clay desert, that is perfectly free from sand, when one of these storms is raging. A few hours suffices to cover the interior of the tent with a thick layer of drift-sand, and there will be another layer to the leeward of the tent. And if, when you are out in the open, you stoop down and face the wind, you can feel the particles of sand striking against your skin, and in the hollows or narrow passages, e. g. between two dried tamarisk-mounds, you can see the whirling sand literally driving along like smoke or mist. Now this drift-sand, which is derived from the crumbling ranges of the Kuruk-tagh, and perhaps also from those of the Bei-schan and the Tschöl-tagh, does, in contradistinction to the ephemeral and rudimentary fluviatile dunes beside the lower Tarim, form a real addition to the material in the sandy desert. And as disintegration is a constant process, which here takes place through the agencies of aridity, being in especial promoted by the wide range of temperature not only between winter and summer, but also between day and night, and as the wind, in respect both of its direction and its force, is likewise constantly operative, it follows that the augmentation of the sand in the western part of the Desert of Lop must also proceed with a similar degree of regularity. The loss which the Kuruk-tagh experiences in altitude is a measure of the gain which the sandy desert makes through the transporting power of the wind. There can hardly be any other region on the earth in which this process is taking place with the same degree of distinctness, on the same stupendous scale, and at the same rapid rate. You both see and hear the actual power of the wind in full operation; on every side of you you have the rush and roar of the tempest and the sand, until you almost fancy you are in a river of solid matter flowing on like a swift torrent.

Through corrasion also the wind helps to crumble down the Kuruk-tagh; for not only does it carry away the disintegrated material that it finds already prepared for it, but the sand with which the atmospheric current is charged exercises a directly corrasive effect upon the surface of the rocks; and the signs of abrasion, and the conchoid excavations that we find here and there, are eloquent evidence of the rasping and eroding power of the sand. Walther says that the telegraph wires between the stations Aidin and Bala-ischem on the Transcaspian Railway have to be renewed every eleven years, their original thickness being by then reduced one-half by the sand-storms. It would have been interesting to learn what effect is produced upon the telegraph poles within the same period. So far as I understand, they would suffer far less from the abrasion of the sand than the iron wire does; otherwise it would be difficult to explain why the poplar-trunks that still stand upright beside the Kuruk-darja and at Lôu-lan, and have stood there dry and exposed for so many centuries, were not long ago totally destroyed. They are, it is true, in consequence of their porosity, saturated through and through with sand and dust; but it is difficult to make out in what way this contributes to their power of resistance.

With regard to the importance of the wind in forming sandy deserts, Richthofen says: »Die Winde operiren wesentlich mit dem gegebenen Material, machen neues frei durch Corrasion und übernehmen das welches in anderer Weise gelockert wurde.« Even though we were to conceive the Desert of Lop to be entirely free from wind, a belt of calms in fact, or even though none but westerly winds prevailed, the western and middle parts of the Tarim basin would nevertheless be filled with sandy deserts just the same, though the deserts would then cover a far smaller area than they do now.

This brings me to the third source for the sand that I have mentioned above, namely, the bottom of the former sea. With regard to this Richthofen says in the

same place: »Der Sand der Wüsten kann von den Dünen eines im Rückzug begriffenen Meeres und den Anhäufungen am Boden der Küstenzone des letzteren stammen, wie in den Umgebungen des Kaspischen Meeres, im pannonischen Becken und teilweise im Tarym-Becken Central-Asiens.»*

When the sea disappeared, the former marine sand became exposed to the wind, which consequently here merely rearranged into dunes the material that it already found to hand, without increasing its quantity; the increase took place, as we have seen, in the eastern part of the basin. At Balkanski Salif and Usun-ada, on the east coast of the Caspian, there exists a beautiful example of the formation of littoral dunes beside a shrinking sea. Similar dunes grew up no doubt along the path of the receding Central Asian sea, but not everywhere, only where the conditions were of course favourable. In some quarters their immediate formation would probably be prevented by vegetation. But after this had in its turn perished for want of water, and after the great arid period set in, the wind too began its irresistible work, driving together the sand that lay quiescent in the primitive bed of the sea, excavating, planing, filing the surface exactly as we see it doing to-day in the Desert of Lop. Simultaneously there would also be liberated immense quantities of mud, which subsequently settled in certain localities in the shape of drift to form loess deposits, as also fragments of animals and plants, which were contained in the former marine deposits. Fragments of this description were discovered by Prof. De Geer in two or three of the specimens of sand that I brought home with me. One of these I took on the 13th April 1895 out of a dune a couple of days' journey east from the Jarkent-darja below Merket. It contained fragments of apparently seed-bearing organs of plants, and a well-preserved shell, yellow and 1 mm. long, of an Ostracod, which De Geer regards as having been undoubtedly transported to the position in which it was found. With regard to a second specimen, taken on the 26th April in the Takla-makan proper, between the Masar-tagh and the Chotan-darja, Prof. De Geer says: »Sie besteht aus sehr feinkörnigem, staubigem, graugelbem Sand mit wenig Magnetit, aber starkem Kalkgehalt. In dieser Probe wurden bei näherer Prüfung ein paar Dutzend gut erhaltener, weisser Schalen von Ostracoden angetroffen. Die grössten Exemplare sind etwa 0.8 mm. lang, aber unterhalb dieses Grenzwertes gibt es zahlreiche noch nicht ausgewachsene Exemplare aller Grössen. Sowohl hieraus als auch aus der grossen Anzahl der Schalen scheint es deutlich zu sein, dass die Tiere an Ort und Stelle gelebt haben, und dass also diese Gegend während der Quartärzeit, aber vor der gegenwärtigen Flugsand-Epoche, unter Wasser gestanden hat. Sei es, dass dieses Wasser ein strömender Wasserzug oder ein grösserer quartärer Binnensee gewesen ist, so werden ohne Zweifel fortgesetzte Untersuchungen über die Verbreitung des ostracodenführenden Wassersediments von Gewicht für die Kenntnis der klimatischen Veränderungen sein, welchen das Gebiet während der Quartärzeit unterworfen war. — Die vereinzelte Ostracodenschale, die in der Probe vom 13. April angetroffen wurde, rührt höchst wahrscheinlich aus einer ostracodenführenden Schicht her, die unter dem Flugsande liegt und der Schicht des Lagerplatzes Nr. XIV (26. April) entspricht.»**

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* *Fuhrer für Forschungsreisende*, p. 443.

** G. De Geer, *Pet. Mitt.*, Ergheft Nr. 131, p. 269.

Dr. J. Gunnar Andersson says, that these Ostracods belong to the family of the Cytheridæ, which consists almost exclusively of marine forms. Two species are represented, namely *Limnicythere inopinata* and *Cytheridea torosa*. The former is in fresh water an immigrant and acclimatised form, but it lives also in brackish water, e. g. the Baltic. The latter is a typical brackish water form, which is found at several places along the coasts of the Mediterranean. Dr. Andersson considers that the presence of the latter species in Central Asia is, from the zoo-geographical point of view, of great interest.*

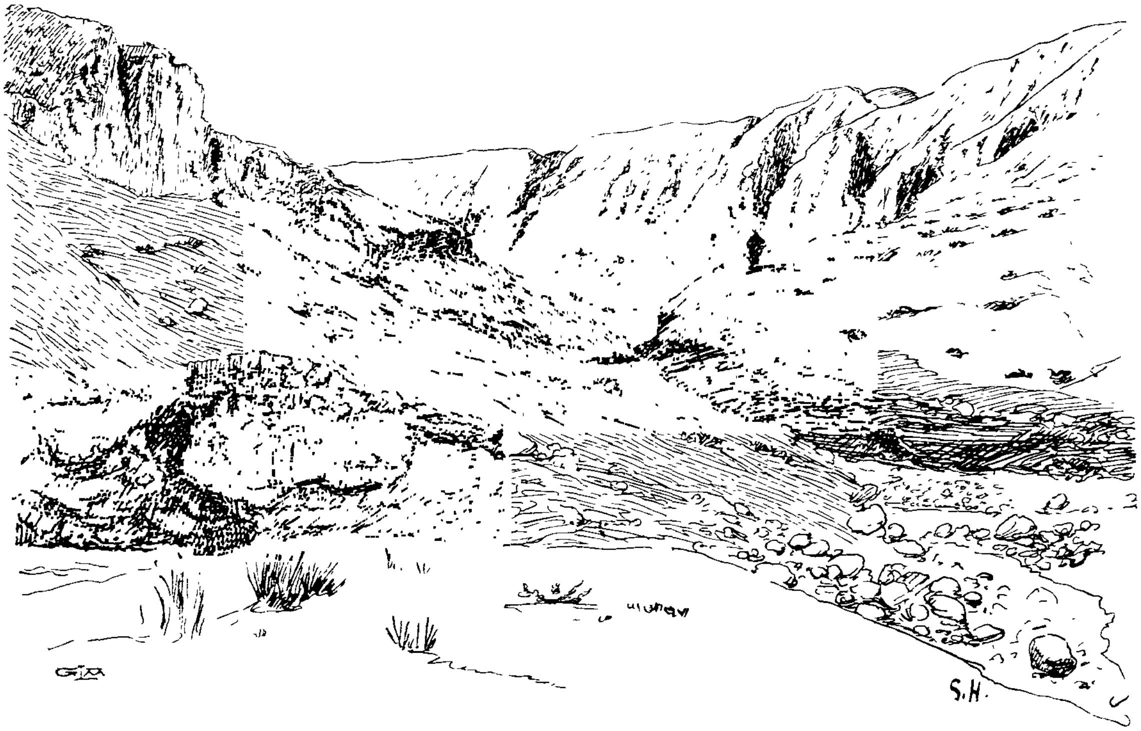

Fig. 197. THE VALLEY OF TOLLAN-CHODSCHA ON THE UPPER ROAD.

Seeing then that the shells of these zoological forms, which lived in the Central Asian Mediterranean, are now found mingled with the drift-sand and, as is proved by the provenance of the first specimen, participating in the migrations of the dunes, we are forced to the conclusion, that the desiccation of that sea was followed by a period in which there existed only small localised patches of dunes, while large areas consisted of bare clay desert with incipient formation of dunes. The sedimentary material of which the desert was composed, and in which these Ostracod shells were included, was subsequently liberated, sifted and sorted, and re-deposited by the winds, so that the intermingling of the Ostracods with the continually increasing desert-sand resulted as a matter of inevitable necessity.

All I mean to say, is that the occurrence of Ostracods almost of necessity presupposes the formation of dunes *in situ*. For if the masses of sand were derived from any other source, whether rivers or lakes or the encircling mountainous regions, from which they were *directly* transported, they would indeed have spread themselves out over the flat parts of the basin just as they do now, but the Ostracod-bearing sedimentary strata would in that case have been buried underneath the outspreading drift-sand, and the shells would never have come to light. In this respect they serve as the characteristic fossil by and through which to determine the origin of the sand. A precisely similar process is now taking place in the Desert of Lop, where the *Limnæa* shells are being, as it were, »dissected« out of the areniferous clay deposits in which they have been inclosed. It is of course essential to represent the formation of the desert as proceeding step by step or region by region, not as taking place throughout the whole of the field simultaneously. In some regions the vegetation would no doubt be able to persist longer than in others, and consequently in these latter the formation of dunes would begin earlier. But the period at which the last traces of this vegetation were destroyed, and the desiccated material was pulverised to dust, is so distant that no remains now exist. The only poplar trunk, white and brittle as glass, that I saw whilst crossing the desert in 1895 was situated only a couple of days' march west of the Chotan-darja, and may possibly have clung to life for a long time with the aid of the groundwater. But as a rule there are no vegetable remains to be seen on the few patches of bare soil that occur at wide intervals apart. Certain of these patches, occurring between Camp No. XIII and the Jaikent-darja and the Chotan-darja, I described in the following manner: »Noch ein paarmal kreuzten wir nackte Flecke zwischen den Dünen; sie bestehen aus salzhaltigem, feinem, hartem Staub, oft mit scharfkantigen, niedrigen Stufen. Das Material ist sehr spröde und porös; von Vegetation enthalten sie keine sichtbaren Reste, und fast gar keinen Sand. — Es ist dies der ursprüngliche Boden, auf dem sich die Dünen (50—60 m. hoch) aufgetürmt haben. Die horizontale Schichtung ist immer sehr deutlich.«*

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* *Loc. cit.*, pp. 269—270.

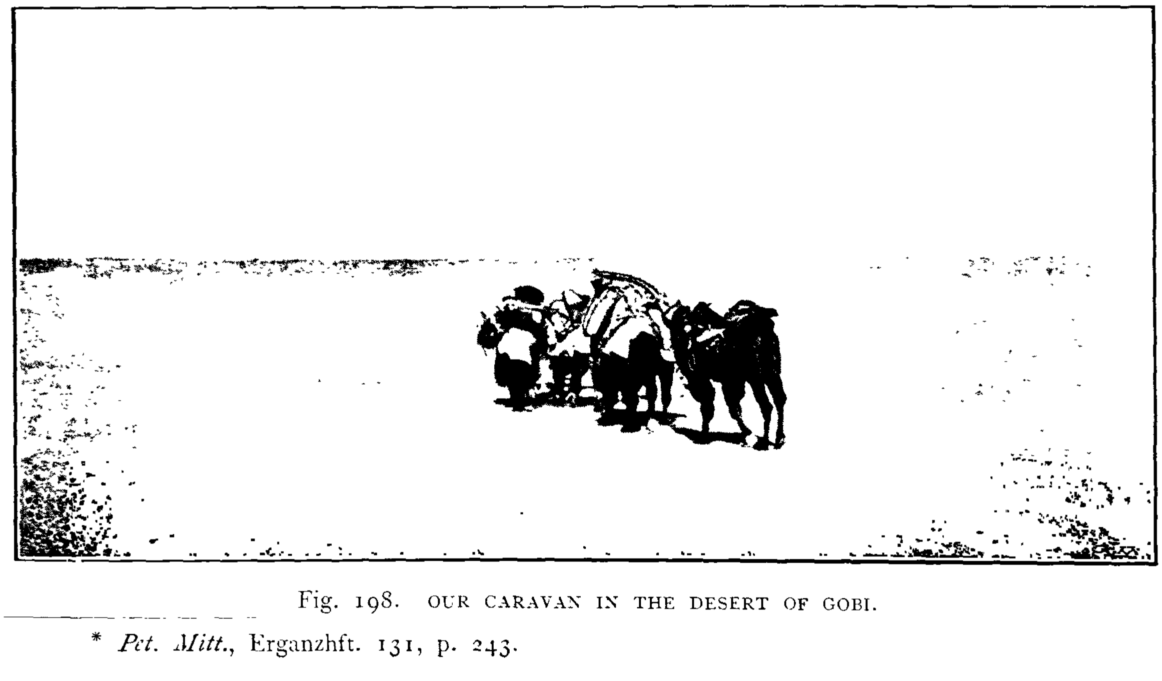

Fig. 198. OUR CARAVAN IN THE DESERT OF GOBI.

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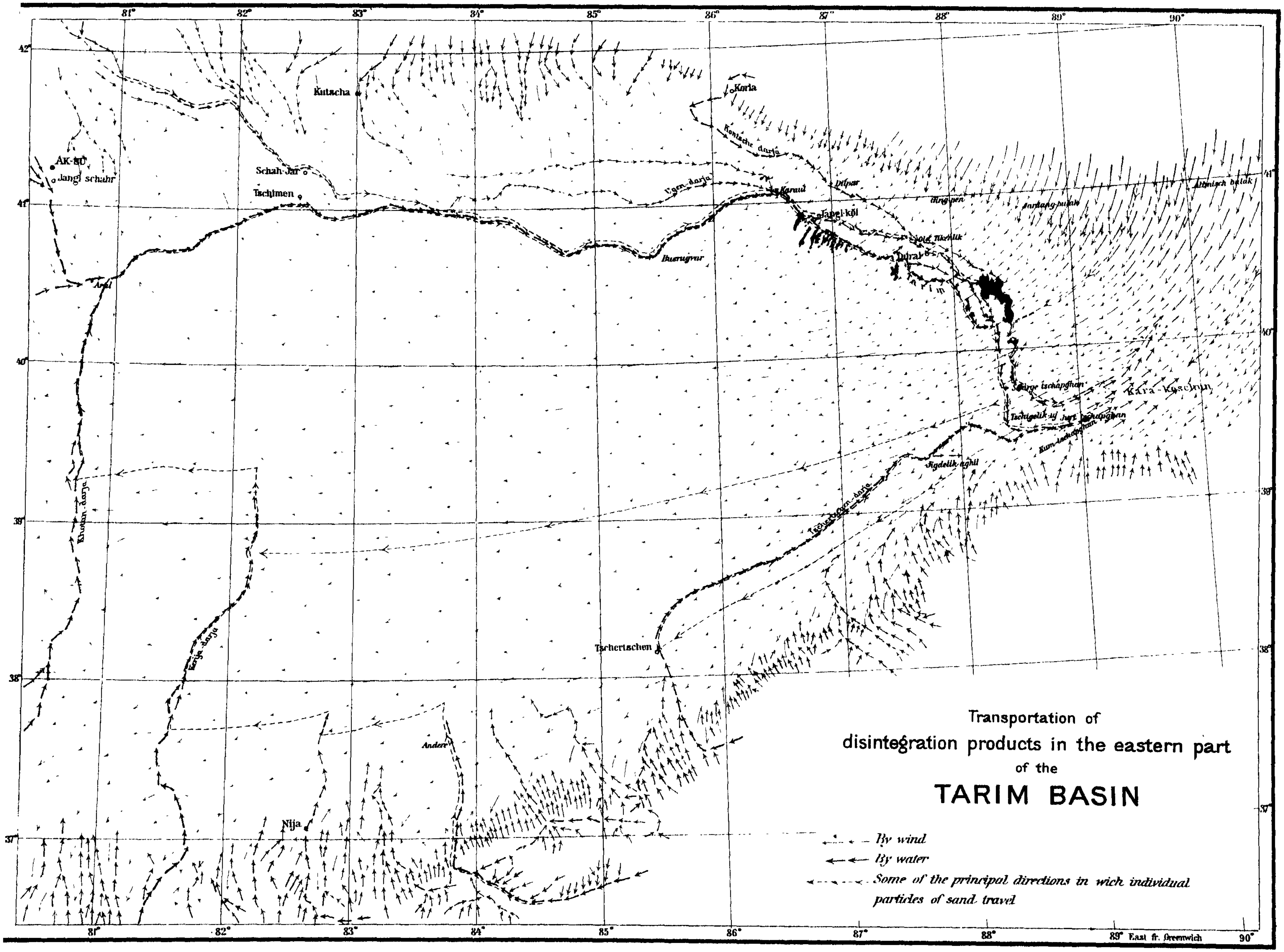
* *Pet. Mitt.*, Erganzhft. 131, p. 243.

The step-like formation in the horizontally deposited clay soil is an effect of the wind similar to the jardangs. It is however uncertain whether there was any sand intermingled with the clay, for I took no specimen for the miscroscope; moreover arenaceous layers alternated with non-arenaceous, as they do in the Lop-nor and Kara-koschun.

Under the conditions that now obtain it is only quite an insignificant part of the sand-covered soil that is exposed to the winds. Setting aside the Desert of Lop, the dunes of the Takla-makan receive but an infinitesimal accretion of sand through the agency of the wind's erosion. In fact this is confined to the areas that are still free from sand, e. g. the bajirs in the Desert of Tschertschen, the depressions of which I consider to have been excavated by the wind. If now the sole sources of the dunes were the sand in the bottom of the former sea and the alluvial sand of the rivers, the distribution of the sand over the basin of the Tarim could not possibly be such as it now is. In that case the whole of the Desert of Lop would to all intents and purposes be quite free from dunes, and the dunes of the Desert of Tschertschen would be only of infinitesimal size, for they would be unceasingly swept westwards by the winds. Were the force of the wind not so terrific as it actually is, one or two unimportant sand-sources would in the course of time be able to give rise to stupendous dune-accumulations; but, the wind relations in the Desert of Tschertschen being what they are, any such combination is quite absurd. At the first onset it is, I admit, tempting to conceive a re-deposition of the desert sand through the agency of the river. But if the river manifests, as we have seen, a decided tendency to shift to the right, and thus brings its right bank into immediate contact with the northern edge of the forest, which it is eating away, as indeed it quite manifestly does from two or three of the photographs in the first volume, then fresh masses of sand are being incessantly swept down from e. g. the mouth of the Ak-su-darja to Karaul and the tracts below, and these masses, when the river along this latter section again shifts its bed, will again be swept west or rather west-south-west by the wind. If the influence of the east wind really does extend as far as to the Chotan-darja, the sand is driven into that river, which then step by step and bit by bit transports northwards the masses of sand which annually accumulate in its bed, that is to say to the region immediately below the mouth of the Ak-su-darja. There the revolution begins again, with the eastward movement of the sand, and theoretically there exists no reason why it should not continue to revolve in this way for ever. The sand which in the course of this revolution enters the Kerija-darja is carried by its temporary floods down to the point where that stream dies away in the desert; but this only amounts to a small interruption or gap in the elliptical orbit, the theoretical paths of which are represented on the accompanying little sketch-map.

It is indeed conceivable, that milliards upon milliards of particles of sand have already described similar paths once or it may be twice. But they are certainly infinitesimal as compared with the immense masses of sand that are carried by the prevailing wind to regions in which variable winds blow, and where they become stationary, oscillating within strictly circumscribed limits. Add to this, that the volume of the water bears no sort of reasonable proportion to the volume of the



Transportation of disintegration products in the eastern part of the **TARIM BASIN**

- By wind
- By water
- Some of the principal directions in wich individual particles of sand travel

Gen. Stab. Lit. Anst. Stockh.

sand. Consequently its re-depositing power, which is indeed exercised, would never be able to bring about such a powerful effect. Thus the re-deposition alluded to with the assistance of the water is merely an episode, a subordinate phenomenon, which loses all significance when compared with other far more important agencies. At all events the materials with which the river operates are, as I have said, such as exist already, and to which it no longer makes any addition. All the more powerful therefore and all the more active is the energy it puts forth in the opposite direction, that is in arresting the sand, along the stretch between Karaul and Arghan, where it breaks down the dunes that the wind has built up and washes the sand farther down the river-bed.

In view of these facts and observations, I am unable to arrive at any other conclusion than this, that at the present day the wind is almost the only factor, at any rate it is the most powerful factor, in augmenting the dunes in the Tarim basin. And in support of this view I appeal to the distribution of the sand, and its varying thickness. From the locality in the Desert of Lop where the drift-sand stops in order to form incipient dunes, the dunes go on increasing in height as they lie farther and farther west, until finally they reach their maximum height in a belt which is probably situated somewhere between the line of the Jangi-köl-Tatran and the Kerija-darja. After that they are rather lower, although the quantity of sand no doubt remains relatively the same, for it is spread out wider and occupies a larger area of the surface. In the level and regular rise from east to west the course of the Tarim makes but an accidental and temporary breach, which nevertheless entails certain, but entirely local, irregularities in the architecture of the sand. Great though the river's force undoubtedly is, it is quite unable to alter the broad features of the distribution of the sand. Indeed how insignificant are all these narrow ribbons of water when contrasted with the immense areas that are covered with sand! Add to this, that the period of the pendulum-like oscillations of the lower Tarim from north to south and from south to north is short in comparison with the velocity with which the dunes travel. The effects produced by every fresh change of bed will therefore not be very far-reaching, and the channel which the river has carved for itself through the sands, and now follows, would therefore pretty easily be filled up again, were the river to return once more towards the north.*

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* This may be illustrated in a still greater scale by the following citation from A. de Lapparent's excellent work: «Sur un désert, le vent n'a ni la même force ni la même constance que sur le bord de la mer: aussi la mobilité des dunes y est-elle plus capricieuse, et selon la saison, le sens de leur marche peut varier. Néanmoins l'ensemble des vents offre toujours, dans chaque région, une résultante de sens déterminé, qui définit la direction générale du transport. C'est ainsi que les sables du désert de Libye tendent sans cesse à envahir l'Égypte, où ils ont enseveli, non seulement des monuments anciens, mais même des villages, dont la submersion par les dunes est postérieure à l'introduction de l'islamisme dans le pays. La marche vers l'est ne s'arrête guère qu'a la vallée du Nil, dans laquelle les sables s'engouffrent, augmentant la quantité des matériaux détritiques que charrie le fleuve. Au delà de cette vallée, le phénomène atmosphérique se fait encore sentir sur la bande comprise entre le Nil et la mer Rouge: mais, faute de matières transportées, il se borne à faire de ce pays un *désert de pierres* en enlevant, pour le jeter dans la mer, le sable primitivement mélangé aux cailloux . . . . .

Dans le désert de Gobi où le vent du nord-est domine, la partie orientale est un désert de pierres, tandis que les sables s'accumulent dans l'ouest. La mer Caspienne se comble à l'est, par les sables que le vent apporte du désert de Touran et, au nord-ouest du Sahara de grands bancs de sable envahissent l'océan Atlantique. Sur plusieurs points du globe, ces transports de sables, en barrant

It does not require any very profound study of the distribution of the sand in the Desert of Tschertschen and the Desert of Lop, to become convinced that it is the wind alone which must have been the cause of it, and a wind moreover which is continually charged with a constant amount of drift-sand. The Desert of Lop is narrow as compared with the Desert of Tschertschen, and unless there was a constant supply of fresh material, the migrating dunes would grow lower and travel faster as soon as they emerged upon the broader and more spacious region. But instead of doing so, they increase in height and size upon emerging. This can only be explained on the ground that the more easterly the dunes the swifter they travel in consequence of their diminutive size, and consequently there is every probability that these easterly dunes will overtake the westerly ones. Thus the sand is accumulating in the Desert of Tschertschen; and this would not be possible, were the supply of sand not continuous and uninterrupted. Hence we get to the kernel of the problem when we ask, where does this constantly feeding sand-stream come from? It cannot come, except to a very slight extent, from the dry, superficial layer of the eastern Desert of Lop, for if it did, the surface of the desert would obviously have to be excavated to an extraordinary, not to say to an absurd, extent. Even if that surface consisted exclusively of sand, it would have been excavated to a depth of 125 m. before it could accumulate such masses of sand as fill the Desert of Tschertschen. But seeing that the surface consists, not exclusively of sand, but for the most part of clay, it would (to satisfy the same condition) require to be excavated to twice or three times that depth. That wind-erosion on this vast scale cannot have taken place is best proved by the shape of the Desert of Lop, that is to say by its almost perfect horizontality. Theoretically, a regular and powerful atmospheric current, blowing across a region in which it does not deposit the drift-sand it carries with it, but only excavates, is indeed able to produce a considerable depression. But in the Desert of Lop this result is counteracted by the quantities of water which fill the deepest parts of the basin with solid material, and bring them up *au niveau* with the country adjacent. What therefore during a certain period has been gained through the erosion of the wind is lost again by the deposition, through the assistance of the water, of sand and silt. Precisely the same amount of solid material as is carried away in one place is accumulated in another, the result being a flat alluvial expanse instead of a conchoidal depression.* Here then we have the predominance of a

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le chemin aux fleuves, les ont obligés, tantôt à se perdre, tantôt à s'infléchir, pour retrouver une issue, dans une direction différente de celle qu'indiquait la pente générale du terrain.» (Traité de Géologie, p. 150, 151.)

* The same opinion which I have developed in the preceding pages I find maintained also by Rolland, who speaks of gullies in sandstone, many meters deep, which have been excavated by sand-carrying wind: «Le sable sec, c'est un fait général à la surface du Sahara, est un outil puissant d'érosion, avec le vent pour moteur . . . Sur les grès d'atterrissement l'érosion devient encore plus énergique, quand la roche est suffisamment tendre. On trouve, par exemple, sur un des parements du Gara Krima, près de Ouargla, des sillons larges et profonds de plusieurs mètres dus à un rabotage de ce genre . . . Ainsi la surface des grès d'atterrissement, s'effritant d'elle-même et rongée par les sables, puis remise à nu par le vent et offerte de nouveau sans défense à l'action persistante des agents de désagrégation, se réduit lentement, mais incessamment, en poudre plus ou moins grossière. Certains de ces grès sont naturellement friables; certaines alluvions sableuses et limoneuses sont à peine agrégées. Des matériaux siliceux deviennent libres de toutes parts, et ce sont eux qui alimentent les dunes.» (*Géol. du Sahara Alg.* pp. 215—217).

law of equilibrium, which effectually precludes all idea of the Desert of Lop being the place of origin of the masses of sand that have accumulated farther to the west. Accordingly we have no alternative but to seek for the origin of the sand in the Kuruk-tagh in the first place, and then, further, in the Tschöl-tagh and the swelling which lies between those two ranges. And as an actual fact the whole of that region does bear plain indications of being but the ruins of what it once was. As you travel from the Chan-tengri to the Bei-schan, you find that the ranges and their crests grow continuously lower, as well as both more arid and more disintegrated. In proportion as water and vegetation diminish towards the east, the more do the materials liberated by disintegration fall a prey to the winds and their transporting power. It is not however the wind that has levelled down the former summits of the Kuruk-tagh; they have been broken down by the forces of disintegration, and the process of demolition has been accelerated by corrasion. The storms then swept, and still continue to sweep, the loose material farther and farther towards the west-south-west. Thus a river of drift-sand has for countless thousands of years been streaming across the basin of East Turkestan, and when it has been unable to advance farther, the masses of sand have gone on increasing in volume and the desert has extended more and more. When the migratory lake of Lop-nor shall finally have disappeared, and the extreme tentacle of the Tarim shall have died away in the sand higher up its course than it does now, the wind will then be able to excavate the Desert of Lop unchecked, producing a deep depression, the centre of a never-ending aridity.

# CHAPTER XXXII.

## SPECIMENS OF SAND, DUST, AND MUD.

Here it will perhaps be a convenient place to state the results of the analysis of a number of specimens of sand, dust, and mud which I brought home with me. The specimens from the 1894—97 journey are described by Professor Baron G. De Geer, and those from the 1899—1902 journey by Mr. Gregori Aminoff, under the direction of De Geer. For the present purpose a detailed mechanical and petrographical examination was considered superfluous, a brief general analys is being all that seemed called for.

Each specimen was tested with hydrochloric acid, in order to determine the carbonate it might contain, and with the magnet, to ascertain its percentage of magnetite; and further it was examined with an ordinary microscope, to see if it contained organic remains. The magnitude of the particles or grains was determined by comparison with sedimentary products, after sifting them through a Schöne sorter. Grains possessing a magnitude of 2 to 0.05 mm. are termed sand, those of 0.05 to 0.01 are termed dust, and those smaller than 0.01 are termed mud or clay. Mixed products are classified according to the predominant ingredient, and by the same rule a discrimination was made between coarse-grained sand, 2 to 1 mm.; medium-grained, 1 to 0.5 mm.; and fine-grained, 0.5 to 0.05 mm.*

The following specimens were obtained in the Desert of Tschertschen, i. e. that part of the great sandy desert of the Tarim basin which is situated between the lowermost course of the Tarim and the Tschertschen-darja.

A specimen from the Ettek-tarim, taken on the 17th February 1900, consists of fine yellowish sand, principally non-rounded grains of quartz, mica, and felspar; strongly calciferous, with a moderate percentage of magnetite.

The next specimen was taken from the lofty dune-accumulations beside the Tus-alghutsch on 7th Dec. 1899 — fine, yellowish sand, consisting of non-rounded grains of quartz, felspar, and mica (muscovite), and containing

1.7 per cent of grains bigger than 0.5 mm.
98.3 » » » » less » 0.5 »

This specimen was moderately calciferous, and had a large percentage of magnetite.

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* *Peterm. Mitteil.*, Erganzhft No. 131, p. 268, where Prof. De Geer's report on the specimens of my earlier journey will be found.

The following specimens come from the Desert of Tschertschen. First, one from Camp. No. III, taken on 22nd December 1899 — fine, yellowish sand; a preponderance of sharp-edged grains of quartz, mica, and felspar; strongly calciferous; a heavy percentage of magnetite. On the same day we passed, in bajir No. 5, the flat-topped clay terraces already described, and called by the natives *jardang*. A specimen taken there proved to consist of

(1) loess concretions;
(2) concretions of bog iron-ore;
(3) a fragment of wind-worn, hard, black rock;
(4) two or three fragments of a weathered grey mineral.

A specimen of salt, taken from bajir No. 13 on 23rd Dec. 1899, consists of common salt, intermingled with sand. This substance is very common throughout the desert wherever the ground is free from sand, and as a rule forms hard layers or cakes (lamellæ).

In bajir No. 20 (25 Dec. 1899), we found pure gypsum.

On 27th Dec. 1899 a specimen taken from the eastern side of a lofty dune-accumulation between bajirs No. 32 and 33 was composed of moderately fine, reddish-yellowish sand, consisting of quartz, mica, felspar, and some dark rock, the grains not being especially rounded. The component grains were

70 per cent bigger than 0.5 mm.
30 » » less » 0.5 »

Very slightly calciferous; moderate percentage of magnetite.

On the same day I took from another place a specimen of fine, yellowish sand, consisting of quartz, felspar, mica, and hornblende. Strongly calciferous; very strong percentage of magnetite.

In one of the last bajirs towards the south I took on 5th January 1900 a fine, yellowish sand of quartz, mica, and felspar, the grains of which were less than 0.5 mm.; strongly calciferous; heavy percentage of magnetite.

In order that these may be compared with the specimens from the more westerly parts of the desert, I will briefly quote some of the results obtained by De Geer.*

Proceeding now from east to west, we have first a specimen taken on 2nd May 1896 from Tschapan-kaldi, beside the lower Tschertschen-darja. It consists of faintly reddish, light grey sand, of moderate-sized grains, beautifully rounded, mostly of white, colourless or reddish quartz, with a pretty large admixture of orthoclase, plagioclase, hornblende, and mica, and additions of quartzite, mica-schist, etc.; strongly califerous.

Another specimen of the 19th February 1896 from the region south of the Atschik-darja contains small fragments of apparently seed and other vegetable remains; in which there is nothing surprising, because the river is quite close, for vegetable remains of that character could not penetrate very far into the desert without being destroyed.

From Camp. No. VII immediately west of the Kerija-darja, I obtained on 26th January 1896 two specimens, one from the north-east, i. e. the windward side of a dune-crest, and the other from the south-west or leeward side of the same dune. Both specimens are fairly calciferous; but, whereas the grains in the former measure 0.3 mm., those of the latter are seldom as big as 0.2 mm. The former contains the larger percentage of magnetite, and its colour is rather darker yellowish brown, more spotted with black, differences that are easily accounted for by the fact that the heavier particles were deposited by the wind on that side. Another specimen, taken in the Takla-makan on the 13th April 1895 from the leeward side of a dune, furnishes a still more decisive proof of the sifting of the material by the wind; for the specimen consists almost entirely of beautiful laminæ of mica, with rounded edges and from 0.5 to 2 mm. in size, consisting partly of biotite, partly of muscovite. The colour of this peculiar micaceous sand is brown and silvery. By way of a subordinate intermixture, the specimen contains also some very fine, strongly calciferous sand with a moderate percentage of magnetite.

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* *Peterm. Mitt.*, Ergänzhft. No. 131, pp. 268—269.

A specimen from Camp. No. XII, in the middle of the Takla-makan (24th April 1895), consists of fine drift-sand, of a conspicuous yellow-brown colour, rather strongly calciferous and with rather a large percentage of magnetite, the grains being seldom larger than 0.2 mm. Another specimen taken not far east of the preceding, at Camp. No. XIV on 26th April, had grains of almost precisely the same dimensions, but of a somewhat lighter colour, as well as more calciferous and with a large percentage of magnetite.

With regard to the specimens taken from the west of the Desert of Takla-makan, De Geer says, that one from Ordan Padschah (11th March 1895) consists of fine-grained drift-sand, of a grey, rather brownish, colour, spotted with black, very strongly calciferous, a slight proportion of magnetite, but with little mica and without vegetable remains, notwithstanding the propinquity of the site to the belt of oases. The grains do not as a rule exceed 0.2 mm.

A specimen from a dune at Lajlik (15th March 1895) is of a purer grey colour, and is heavily impregnated with magnetite, but in other respects resembles the specimen last described. It contains grains of quartz, orthoclase, plagioclase, hornblende, mica, quartzite, mica-schist, and other schists, limestone, calc-spar, and garnet. Here again the dimensions do not as a rule exceed 0.2 mm.

Two specimens taken at Camps No. II and IV immediately east of the Jarkent-darja, in the middle of April 1895, consist of very fine sand, often less than 0.1 mm., of a light yellow-brown colour, with traces of magnetite, rather strongly calciferous, and containing a slight sprinkling of small vegetable remains. Another specimen from Camp. No VI is on the whole similar to these two, except that it is somewhat darker and coarser, the grains being not seldom 0.2 mm. in dimensions.

Both in the interior of the Desert of Lop and in the heart of the Taklamakan I picked up several cylinders of sand (fig. 199), 10 cm. long and 1 –2 cm. thick, composed of rather hard fine-grained sand. According to De Geer, these have been unmistakably cemented together by carbonate of lime, and shed off at the roots or stalks of the kamisch. In this way particles of sand which ordinarily are only 0.2 to 0.5 mm. in dimensions, form a solid accretional mass. De Geer rightly regards these formations as proofs that vegetation existed when the drift-sand era began. In the Desert of Lop, where similar sand-cylinders are abundant in certain places, we are able to prove by other means that vegetation did exist. According to Aminoff, the specimens found in the Desert of Tschertschen are as strongly calciferous as the specimens which De Geer examined from the Western Takla-makan.

Unfortunately these specimens of sand which I brought home with me are all too few to warrant perfectly trustworthy general conclusions being drawn from them as to the changes the drift-sand may undergo in the course of its journey towards the west. And the difficulty is further enhanced by the specimens having been taken at such widely scattered and irregular points all over the desert. Apart from this, specimens which should, properly speaking, be compared with one another ought to be taken from the corresponding sides of the dunes, and these again ought to exhibit the same disposition with regard to the direction of the wind; that is the specimens ought to be all taken from the west-south-west leeward face or all from the east-north-east windward face. The most conspicuous properties, and those which prove most clearly the occurrence of such a progressive metamorphosis in the sand, would naturally be the shape and size of the grains. The following general summary gathers up the results of these characteristics in the case of the specimens above described.

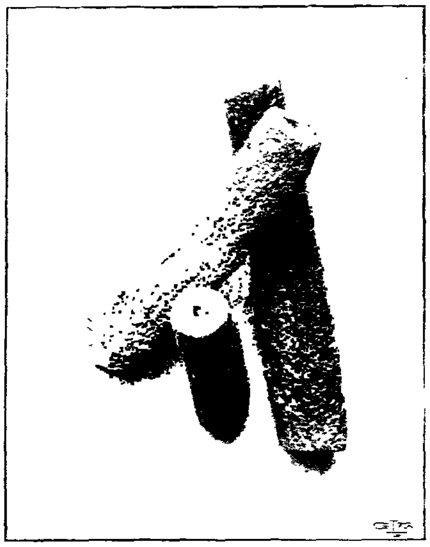


Fig 199.

(1) The sand-grains of the Ettek-tarim region have not generally been rounded.

(2) Those of the Tus-alghutsch are not round.

(3) Most of the grains from Camp. No. III in the Desert of Tschertschen have sharp edges.

(4) The grains from between bajir No. 32 and bajir No. 33 are not especially rounded.

(5) Those from Tschapan-kaldi have been beautifully rounded.

(6) Those from the western Takla-makan are also beautifully rounded.

Now it cannot be pure chance, that the alteration in shape which these six typical specimens exhibit agrees so well with the law which would *a priori* be expected to obtain throughout the desert. The nearer the grains lie to their primary source, the Kuruk-tagh, the sharper are their edges; and in proportion as they travel towards the west, they become increasingly more rounded in consequence of the filing, friction, and rubbing to which they are there subjected. Still, as I have already said, it is difficult to derive any clear conception of the extent to which the law obtains; for if it really does hold, we should expect to find in the Desert of Lop, across which the greater part of the drift-sand has been swept that now fills the western deserts, nothing but sharp, angular grains. But, as we shall see presently, when I come to describe the specimens taken from the Desert of Lop, perhaps most of the grains there are also rounded. For instance, while the grains in one specimen taken on 1st April 1900 to the north of the Kara-koschun are not rounded, those of another specimen have very sharp edges and contain splinters of gypsum, though these latter were probably *in situ*. Possibly the explanation of the occurrence of rounded grains, intermingled with sharp-edged ones, which appears to characterise the Desert of Lop, may be this: the former come from the most eastern parts of the Kuruk-tagh and the Bei-schan, and consequently have a very long way to travel before they reach the Desert of Lop, while the latter are derived from the western Kuruk-tagh, and thus have travelled but a relatively short distance. And support is lent to the view, that this really is the cause of their contemporaneous presence, by the general summary given above. If we compare (2), (3), (4), and (5), we shall notice that the smoothness and roundness of the sand-grains increase regularly from north to south: in the extreme north they are not rounded at all, at Camp. No. III they are sharp-edged, at bajir No. 32 not especially rounded, and at Tschapan-kaldi, in the extreme south, they are described as beautifully rounded. The last-named are derived from the mountainous regions in the extreme east-north-east and north-east, where the wind-relations are the same as those which obtain in the Desert of Lop. Specimen (4) may come from the region east of the Alt-misch-bulak; and specimens (3) and (2) from the extreme west of the Kuruk-tagh, e. g. the region of Budschentu-bulak and Suget-bulak. But on this point we cannot feel quite certain until we have a large number of specimens taken along one straight line running right across the desert from the one side to the other, beginning at Ullugh-köl and proceeding west-south-west all the way to Karghalik; but practically it would be almost impossible to make such a collection.

With regard to the size of the grains, the descriptions given above furnish the following summary: —

From Tus-alghutsch they are, with few exceptions, less than 0.5 mm.

Bajir No. 32 — for the most part greater than 0.5 mm.

In the desert immediately west of the Kerija-darja, 0.2 to 0.3 mm.

In the west of the Takla-makan, the laminæ of mica are 0.5 to 2.0 mm.

In the middle of the Takla-makan Desert, seldom greater than 0.2 mm.

In the western Takla-makan, not seldom 0.2 mm.

In the same desert, immediately east of the Jarkent-darja, frequently less than 0.1 mm.

At Lajlik, generally not more than 0.2 mm.

At Ordan Padschah, generally not more than 0.2 mm.

Although these specimens were gathered at hazard, nevertheless they appear to prove pretty conclusively, that the sand grows finer from east to west; and this is indeed just what we should expect, seeing that the desert is one in which the prevailing wind — the agency by which the movements of the sand are exclusively regulated — blows from east to west. The specimen of rounded mica, 2 mm. in diameter, which comes from the western part of the Takla-makan proper, is only an apparent exception. The laminæ of mica have been sifted by the wind, and are only accumulated on the steep leeward sides of dunes that face the west and south-west, as they do in the Desert of Tschertschen. They occur within a very circumscribed area in the vicinity of Camp. No. IV., situated west-south-west of the Tusluk-tagh and Tschoka-tagh. And equally whether they are derived from any part of these mountains or have been brought there from the mountains which hem in East Turkestan on the west — for the westerly winds do sometimes blow there — the seat of their origin is certainly not very far distant. Anyway we may not assume that they come from the Kuruk-tagh; for the distance is so great, that they would be reduced to powder by friction on the way; and we should also find in the eastern part of the Desert of Tschertschen similar laminæ, only bigger than 2 mm., whereas in point of fact there are none. Moreover there exists good reason to believe, as I have attempted to show, that the constant east-north-east wind of the Lop country does not prevail in the western parts of the basin; the winds there are more irregular and more variable.

The following specimens are derived from the Kuruk-darja, the Desert of Lop, and the Desert of Gobi.

At Camp. No. VII, I took, on 14th March 1900 from the terraced bank of the Kuruk-darja, a specimen of yellowish brown dust, strongly calciferous, but with no magnetite to speak of. A specimen from the edge of the upper saj terrace facing the Kuruk-darja, taken on 19th March 1900, consists of yellowish grey powdery sand, moderately calciferous, and with a moderate percentage of magnetite. Another specimen from the bottom of the Kuruk-darja, taken on the 20th March 1900, is very similar — yellowish brown dust, strongly calciferous, and with no magnetite.

In the northern part of the Desert of Lop I took on 10th March 1901 a specimen of grey powdery clay. Two days' south of that point we found, lying loose on the surface, concretions of gypsum, containing a certain percentage of calcium carbonate. Yet one day farther south (13th March 1901) the ground consisted of yellowish grey powdery sand, moderately calciferous, and with slight traces of magnetite.

Along the line I levelled across the Desert of Lop, and in the middle of the desert, I obtained on 13th March 1901 a specimen of sand which contains splinters of gypsum as well as shells of *Limnæa ovata* and a quantity of vegetable remains; it was strongly calciferous, contained a moderate amount of magnetite, and the grains consisted of

| | | |
|---|---|---|
| 6.3 | per cent. | 2 to 1 mm. |
| 6.3 | » » | 1 to 0.5 mm. |
| and 87.4 | » » | less than 0.5 mm. |

Here then the sand-grains are considerably bigger than anywhere in the Desert of Tschertschen.

On the 14th March 1901 I took a specimen of common salt, which contains also some $H_2 SO_4$ and Mg.

A specimen of clay taken on 30th March 1900 from the middle of the Desert of Lop, between Camp No. XVII and Camp No. XVIII, is pronounced by Aminoff to be mud; which is undoubtedly perfectly correct, for the region in which it was taken was formerly occupied by the lake into which the rivers of the Tarim system formerly emptied themselves. The characteristics of the specimen are — grey, argillaceous, calciferous, powdery sand.

From Camp. No. XIX on 1st April 1900 — fine, yellowish-grey sand, less than 0.5 mm., containing quartz, mica, and felspar, and two or three laminæ of gypsum; the grains not rounded; strongly calciferous; a heavy percentage of magnetite.

From the Desert of Gobi on 30th January 1901 — fine, reddish yellow drift-sand, consisting principally of quartz, felspar, close black-grained rocks, and mica; most of the grains rounded, moderately calciferous, strongly impregnated with magnetite. The same day I took from a »jardang« terrace another specimen of reddish yellow, fine powdery sand, the grains predominantly round, moderately calciferous, with a large percentage of magnetite.

On the 5th February 1901 I took the following remarkable specimen of fine, rather round and polished gravel out of a very thin layer lying upon low dunes of drift-sand. It consists of 6.5 per cent of grains of quartz, and silicious slate, together with some eruptive rocks of younger age, exhibiting a semi-porphyritic structure. The grains consisted of 65 per cent. bigger than 3 mm.
and 35 » » less than 3 mm.

On the same day I took a specimen out of a high detached jardang, forming a table-like elevation — yellow powdery sand, strongly calciferous, no perceptible trace of magnetite.

On 7th February I selected a specimen from the clay terrace at Toghrak-kuduk, consisting of (1) reddish, calcareous clay; (2) cemented sand, consisting principally of grains of quartz and felspar less than 0.5 mm., and strongly calciferous.

From the distinctly marked terrace which borders on the north the part of the Desert of Gobi that I crossed over, I took on 9th February 1901 a specimen of yellowish brown dust, which Aminoff considers, and rightly, to have belonged to a loess formation; it consists principally of grains of quartz but slightly rounded.

The specimen of fine gravel or coarse sand described next came from the clay desert which we crossed on the 18th February 1901. It contains:

(1) well-rounded grains of quartz, very often with their surfaces slightly abraded by the wind;

(2) similarly rounded grains of silicious slate;

(3) a few grains of felspar;

(4) crystals of gypsum, showing facies of (110), (010), and (111); also a twin crystal.

The grains are 71 per cent. bigger than 2 mm.
and 29 » » less » »

The quartz + felspar = 24 per cent.
Silicious slate = 57 » »
Gypsum = 19 »

Here it may be convenient to adduce the information which Prof. De Geer and Aminoff have given me regarding the vertical section, alluded to in the chapter of Lôu-lan where it is also reproduced. The section belongs to the 6th March 1901, and is that of a deposit of Lop sediment. The bottom layer is of a yellowish grey colour, is rather strongly calciferous, but contains no appreciable proportion of magnetite. The second layer is light grey, is rather strongly calciferous, and contains fragments of finer grey matter. The third layer is also light grey and rather strongly calciferous. In this connection it is especially interesting to notice the evidences of organic life;

for the layer exhibits specimens of *Limnæa auricularia*, (a variety of the same species, which occurs everywhere throughout the old basin of Lop-nor, is called *L. ovata*) and a species of *Planorbis*, very closely resembling *P. marginatus*, but without the lip to the shell; also the vertebra of a fish. This last is however so decayed that it is impossible to determine what species it belongs to; though there can hardly be a doubt but that it belongs to one of the species of fish now living in the Kara-koschun. Did time and opportunity permit, an examination of the various layers over a small area would probably reveal numerous vertebræ of fish, if not entire skeletons. The discoveries would however all belong to the same species, and investigation would hardly pay for the trouble, because we already possess more than sufficient proofs that this spot was formerly situated on the shore of a freshwater lake.

The fourth layer from the bottom is a light yellowish grey, and rather strongly calciferous. Like the layer immediately below it, it contains shells of the same species of *Planorbis* as well as the seed-vessel of some plant. The topmost layer is also light yellowish grey, is intermingled with fine sand, and is rather calciferous. It contains shells of *Limnæa auricularia* and the same species of *Planorbis* as the two layers immediately below it. In this layer the vegetable remains are more abundant than in the lower layers.

On Pl. XX I have brought together a number of mollusc shells from the Desert of Lop. In the top row are five more or less well preserved specimens of *Limnæa stagnalis;* in the second row seven specimens of *Limnæa auricularia*, especially well-preserved and free from blemish, probably they were quite recently dissected by the wind out of the freshwater sediment in which they lay inclosed for centuries. In the third row we have nine more examples of the same species; their bleached appearance, rough exterior, and jagged edges show that they have been for a long time exposed to the influence of the atmospheric elements; from this cause they become eventually brittle and crumble to fragments, and finally are destroyed altogether. The fourth row contains nine more specimens of *Limnæa auricularia*, still filled with clay as hard as cement, with sand and fragments of shells, which they brought with them from the sedimentary beds in which they lay buried. The fifth row consists of ten small, well preserved examples of the same species, which have quite recently been exposed. In the lowest row are specimens of *Limnæa ovata* and *Planorbis*, taken out of the three uppermost layers of the last vertical section from Lôu-lan.

Fig. 200. A WIND-WORN STONE, QUARTZITIC SANDSTONE, FROM THE DESERT OF LOP.

Finally, I adduce the results of the examination of certain specimens of fluviatile mud. The first was taken out of the bed of the Jarkent-darja at Schäschkak on 20th September 1899. It consists of fine, light-grey sand of quartz, mica, felspar, and hornblende, and is strongly calciferous, with a moderate proportion of magnetite. A specimen from the Jarkent-darja at Kuruk-asti (taken on 2nd October 1899) consists of grey calcareous, argillaceous dust, with no perceptible traces of magnetite. A specimen of 7th October 1899 from the bottom of the Tschöl-köl consists of grey argillaceous powdery sand, strongly calciferous, but with only slight traces of magnetite. Owing to the connection that exists between the Tschöl-köl and the Sorun-köl, it may be assumed that this specimen contains only a small proportion of river mud, the greater part consisting of drift-dust and drift-sand, which have settled in the lake. A specimen taken out of the bed of the Jarkent-darja on the 16th October consists of fine light-grey sand, though only a few grains of mica and gypsum are coarser than 0.5 mm. The rest, consisting of quartz, mica, and felspar, is much finer. It is moderately calciferous and has a very heavy proportion of magnetite. Another specimen from the bed of the Jarkent-darja, taken on the right side, at Matan, on 24th October, consists of very fine, brown-grey, calcareous sand. On 2nd November I took immediately below Läschlik, at the confluence of the Kara-kirtschin with the Tarim, a specimen of grey clay, highly calcareous.

On 6th November I took out of the Tarim at Bostan the following specimen of the mud at the bottom — a yellow-grey, very fine sand, consisting of quartz, felspar, mica, and hornblende, strongly calciferous, and with a very heavy percentage of magnetite. On the same day another specimen was taken a little lower down, at Kara-daschi, which possesses essentially the same properties as the former — light grey, very fine sand, of quartz, felspar, mica, and hornblende, moderately calciferous, and with a large percentage of magnetite. A specimen from below the mouth of the Intschikä, taken on 14th November, is grey argillaceous dust, moderately calciferous, and with no perceptible traces of magnetite. From Mungus-asti, on the 23rd November, comes a fine yellowish sand, the grains less than 0.5 mm., consisting principally of quartz, mica, and felspar, strongly calciferous, and with but slight traces of magnetite. Lastly a specimen from the bottom of the Tarim on 2nd December 1899 — very fine sand, yellow-grey, moderately calciferous, and with a moderate proportion of magnetite.

The places from which these specimens were taken are too few and too wide apart to justify any general conclusions. For such conclusions we require a regular series, with precise data as to the local relief and the velocities of the river. It would also be very important to know whether each specimen were taken from the alluvial or from the eroded side of the river.

Pl. 52.

*Ljustr. A. B. Lagrelius & Westphal*

VIEWS FROM BELT OF STEPPE BETWEEN ASTIN-TAGH AND DESERT RANGE

# CHAPTER XXXIII.

## FROM THE ANAMBARUIN-GOL TO THE DESERT-RANGE.

The preceding chapters of this, and the whole of the first, volume, being the text to my atlas, have dealt exclusively with the physical geography of the lowlands in the centre of Asia. Before I proceed to give a general *résumé* of the hydrographical system of the Tarim as a whole, I must first devote a few words to yet one more journey across the desert, between Anambaruin-gol and Toghrak-kuduk, that is across that part of the Desert of Gobi which lies between the Kara-koschun, Sa-tscheo, the Astin-tagh, and the Kuruk-tagh, in the course of which journey I crossed the east-north-east extension of the desert that Prschevalskij calls the Kum-tagh. This journey was performed immediately before that to the Bei-schan and Kuruk-tagh described above, and before the levelling of the Desert of Lop. Consequently I had the same equipment as on that occasion, namely seven men, ten camels, and three horses.

I had occasion to send back to Abdal two or three of my men with some horses from the point where the Anambaruin-gol breaks through the outside border-range of the Astin-tagh, where I had one of my principal camps of control. One of the men I sent back, Tokta Ahun, was especially well acquainted with the region, and had repeatedly made the journey between Abdal and Anambaruin-gol. I therefore seize the opportunity to name the points at which he intended to halt during his journey, and I do it the more especially as I myself never travelled by that route, and consequently am unable to give any personal description of it. The road runs along the northern foot of the Astin-tagh proper, but is apparently for the most part separated from the desert by hills and low elevations. The first halt Tokta Ahun proposed to make was west of the pass of Schi-lang-to, the succeeding stages being Ku-schui-cha, Lap-chi-tjuentsa, Toghrak-bulak, Kamuschluk-bulak, Chodscha-schukur, Kum-bulak, Tasch-köl, Göletschen, Dscho-bulak, Musluk-saj, Kosch-bulak, Similanu-Dschan-bulaghi, Basch-kurghan, Toghraklik-tokaj, Tatlik-bulak, Hunglughu, Dungluk, and Abdal, all being places where there exist springs and grass. The journey could thus be performed comfortably in nineteen days. My man was a reliable man, and I have therefore reason to believe that the names which I have just enumerated are correct. They also agree tolerably well with the names recorded by Littledale, who travelled by this same road in 1893 when proceeding from the Lop-nor to the Kuku-nor. Some of the names on his map are corrupt, though they can be easily recognised. Two are different from those given by Tokta Ahun. Littledale's itinerary, going from east to west, is as follows: Nanambal (a corruption of the Mohammedan Chan-ambal, which again is a corruption of the Mongolian Anambar), Kong-lugu, Pushan-saj, Khoya Suga-bulak (= Chodscha-schukur), Kum-bulak, Yash-kul (= Tasch-köl?), Galechan-bulak, Jo-bulak, Kosh-bulak, Jan-bulak (= Similanu-Dschan-bulaghi), Tadlak-bulak (= Tatlik-bulak, below Basch-kurghan), Kurghan-bulak, Ashtshi-bulak (= Atschik-bulak), Tuna-chorak(?), and Abdal. In vol. III I shall have occasion to discuss this road again.

Below the open expansion of the valley, in which we encamped and which we quitted on the 27th January 1901, the Anambaruin-gol flows towards the west-north-west, breaking through the parallel range to the north in a pretty broad straight glen with a gentle fall. The actual channel, in which the current was excessively small because of the prevailing cold, is filled with sheets of ice, some small, some pretty large. The channel is bordered by terraces, frequently precipitous, and in the upper part of the glen 4 m. high, though lower down only 3 or 2 m. The mountains on the right-hand side of the glen are quite low and rounded, while those on the opposite side are both higher and of more imposing dimensions. In an expansion on the right hand side of the glen we found three houses, the stone walls of which, though but scantily plastered, were in a good state of preservation, while on the gentle slopes around were traces of square patches of cultivated ground and of irrigation canals from the brook. In vol. III I shall mention several similar deserted villages; most of these were formerly inhabited by Tungans. Immediately below the village I have just described, the mountains begin to divide and break up into detached groups, while at the same time the glen widens out. Eventually it forms two valleys, separated from one another by an independent ridge. The valley on the right, through which the Anambaruin-gol flows, is narrow and filled with gravel, but the one on the left is flatter and more open. We chose this last to travel down. As it proceeds, it is joined from the left by two or three eroded watercourses coming down from the Astin-tagh. The ground, although stony, yielded a fairly plentiful supply of scrubby plants. A little bit farther on the two branches of the glen reunite; and even before the river emerged from the lowest slopes of the mountains the ice-formations in its channel had come to an end. A short distance farther to the north the channel grew broader still and shallower, as well as more indistinct, until finally it ceased altogether, or rather dwindled away in a number of small rivulets filled with gravel, and all running towards the north. From the last patch of ice we carried a supply sufficient to serve us for ten days.

In the upper part of this transverse glen I observed fine-grained granite, with white veins, dipping 79° towards S. 55° W.; in the middle quartzite lying 76° N.; and lower down a black, hard, very compact variety of rock dipping 52° towards N. 28° E.

The mouth of the glen is guarded both east and west by several projecting spurs and promontories, which gradually melt into the level desert; and as we advanced towards the north-north-west these became fused together, allowing the two parallel ranges, of which the Astin-tagh here consists, to stand out with increasing distinctness. The more distant range, the Tsagan-ula, is lofty and massive, with a beautiful and clearly outlined crest, at that time covered with snow. The nearer range, to the north, the range through which the stream cuts its way, is considerably lower, and less wild and craggy. Both the character of the scenery and the features of the ground then underwent a total change. Within the course of a single hour we found ourselves transferred from the mountains to the level steppe. The gravel decreased in quantity, and finally ceased almost entirely. The snowy covering, which was continuous and unbroken beside the Anambaruin-gol, now grew thinner and thinner, as well as patchy. The soft ground, which was seamed by a number of tiny rivulets or water-channels, and sank slowly, so slowly as to be almost unnoticed by the naked eye, towards the north, was overgrown with *köuruk* and *tereskeu* bushes, forming in places pretty thick scrub, though lower down they were more scattered. Of drift-sand there was here not a single trace. Before us the small detached desert-ranges were noticeable from their varying bright red colours, but otherwise they were strikingly barren and desolate. Immediately to the right of our route ran a little isolated ridge, continued northwards by three small hills. Orographically this ridge is no doubt an offshoot of the Astin-tagh, although it is now separated from it. There was another similar isolated ridge on our left. Between the Astin-tagh and the desert-range we should have to cross over on the following day the view to the west was open and uninterrupted for a vast distance across the

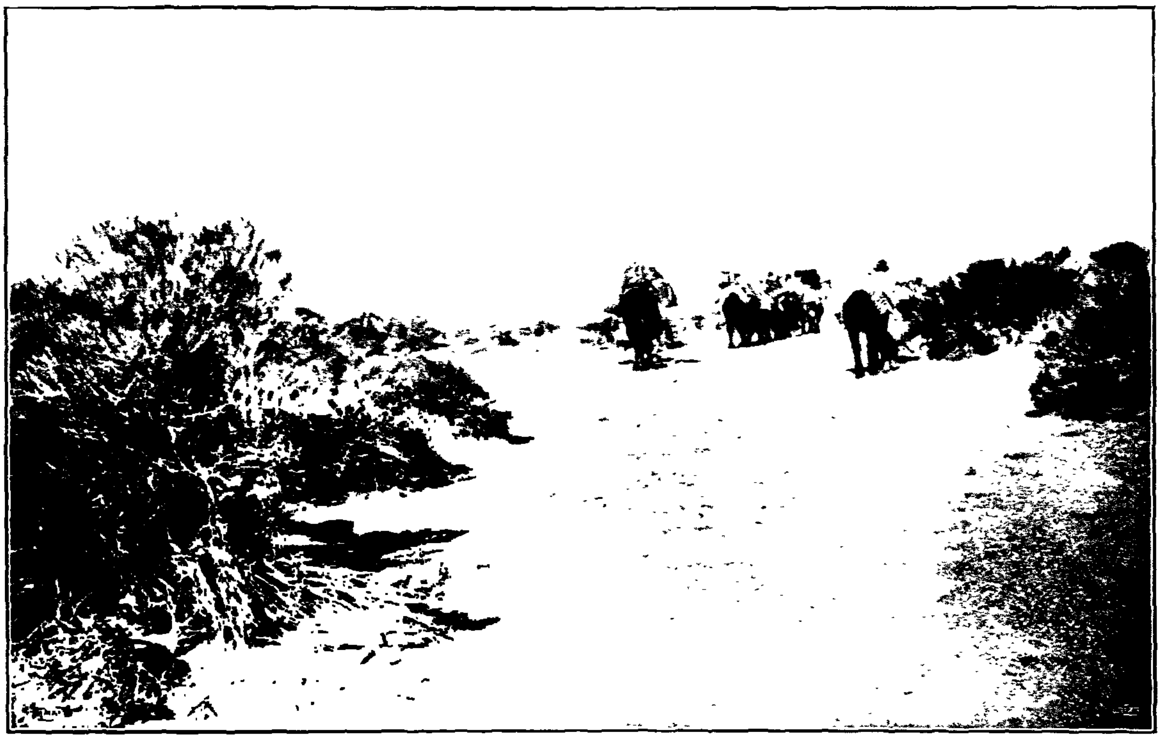


Fig. 201. THICK SCRUBBY STEPPE NORTH OF ASTIN-TAGH.

flat undiversified country, though to the east it was impeded by northern spurs of the Astin-tagh. The massive Anambaruin-ula, in so far as it was visible above the district of Sa-go, stood out sharply and distinctly. We encamped near the last of the three small hills in a dry watercourse, which was bigger than any we had yet seen. At that spot there was an abundance of steppe vegetation, and snow was still lying under the shelter of the terraced banks. There were wild camels in that region.

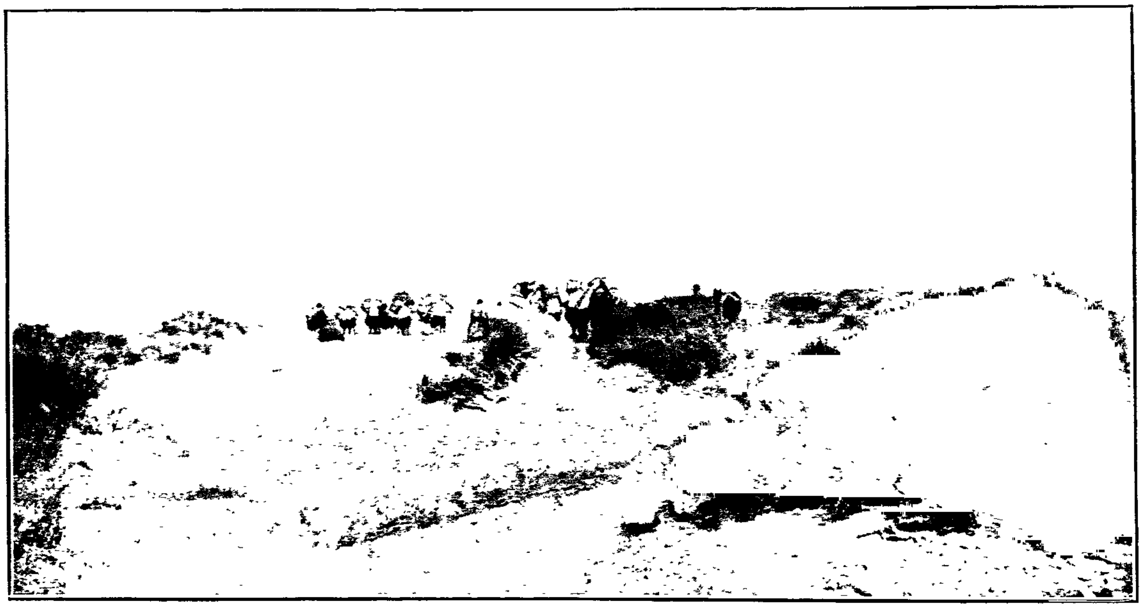


Fig. 202. FIRST GLIMPSE OF THE DESERT RANGE.

On the 28th January the wind blew from the west-north-west, and the sky was clouded, while the atmosphere was thick with wind-blown dust, obscuring for the most part the Astin-tagh. Of the desert-range we could see only the nearest features, everything else, including the little peaks from which I took my bearings the day before, was swallowed up in the haze. The surface was easy to march over, although gravel was still plentiful; but we were able to ride for the most part in the little gullies, which were coated with hard coarse sand. These dry torrents, which are no doubt caused by temporary showers, are here very numerous and run in every direction. No sooner were we across one than down we went into another. They are seldom half a meter deep, but in general extremely shallow, though at the sides, which are sharply sculptured, they show distinct evidences of rainwater erosion. We directed our course towards the N. 30° W., the desert-range appearing rather lower in that direction; moreover the dry watercourses all ran in that direction too. In addition to the scrub already mentioned, we now had *tschakkande*, a species of tamarisk, with stubby stems, roots, and branches, but unusually vigorous. These bushes are thickest at the edges of the larger gullies, but thin out as they recede from them. Their leaves were still green. Here were also numerous withered bushes of a similar character.

On the left a rounded, terrace-like swelling gradually came into view, being at first 1½ m. high, afterwards 2 to 3 m., and bordering a larger watercourse into which several of the smaller ones gathered (fig. 204).

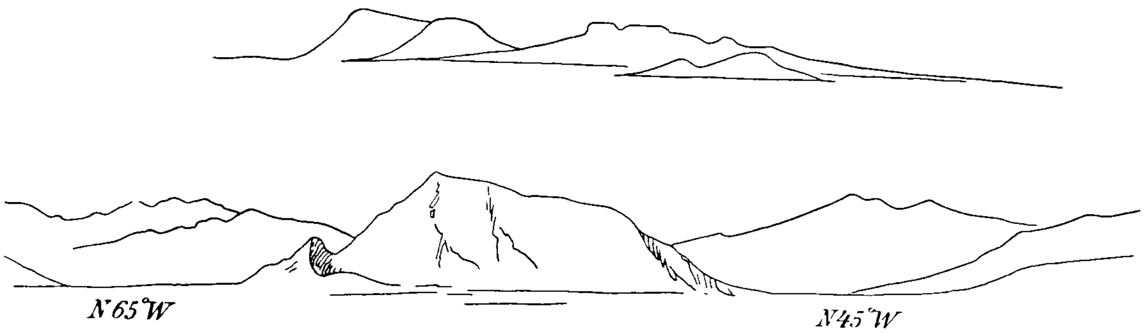


Fig. 203. PARTS OF THE DESERT RANGE SEEN FROM THE SOUTH.

This watercourse then joined, at an acute angle, the principal channel of the region, which was about 100 m. broad and distinctly marked, though shallow. Its bottom was covered with dry, cracked argillaceous mud, diversified at intervals by patches of gravel. An abundance of steppe scrub was growing on its banks, but there was none in the channel itself. Contributory channels entered from both sides, thus helping to form its *saj*. Immediately above us this dry torrent came from the S. 63° E., and below us it proceeded on towards the N. 68° W. Thus in the longitudinal valley between the Astin-tagh and the desert-range, the deepest part of which is occupied by this watercourse, the ground slopes towards both the north and the west, and possibly it continues to slope in the same directions all the way to the Desert of Lop-nor. At all events the desert-range is not pierced in that part by any transverse glen from the Astin-tagh, but lies like a threshold or bar athwart its torrents, compelling the water to flow towards the west. The watercourse runs therefore close to the foot of the desert-range and some small reddish spurs or shoulders that jut out from it actually help to form its bank. To the west the view was again impeded by small groups of hills, low and detached; while to the east the country, so far as we were able to see through the hazy atmosphere, appeared to be open. The largest of the detached hills lay to the north-west.

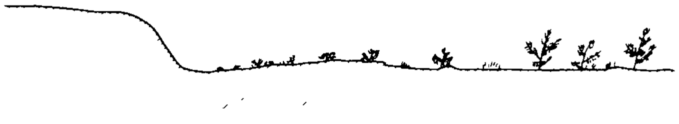


Fig. 204.

We made our way up by a rather narrow glen on the right, which was traversed by a distinct dry torrent, and crossed the mountain-range by a pretty easy *bel*, beautifully rounded and convenient to traverse. Here we found a small heap of stones in a good state of preservation, and in a couple of places on the northern declivity of the pass perceived traces of camp-fires, extinct ashes and embers lying between three stones arranged in a particular way to support a cooking-pot. Whether this was a desert »road», from, say, Chami to Tibet, or merely a hunter's track from Anambar, it is difficult to say. Possibly it has some connection with the route I have mentioned as existing in the eastern Kuruk-tagh.

The drift-sand lies heaped up on both sides of the pass, though in no great quantity, and without forming dunes. On the northern face of the pass, where patches of snow were still lying, the *suksuk* (saksaul) bushes were large and vigorous; though, strange to say, there was not a single one on the southern side.

On the latter slope the rocks consisted of fine-grained, grey granite and veined granite dipping 67° towards N. 70° W. At Camp No. CXXXIII there was granite in various shades of grey, dark yellow, and reddish yellow, as well as pegmatite. Seen from a distance, the faces of the cliffs had a reddish tinge. They lay at 45° towards N. 5° E.

All day on the 29th January we followed the »road» I have alluded to; it was plainly indicated by cairns of stones, crowning small hills and spurs that jutted out at right angles from the mountains. The »guide-posts» consisted sometimes of a large flat stone and a small one propped one against the other, sometimes of a cubical block with one or two smaller, round stones resting upon it. The road or track itself is for the most part obliterated; nor is that at all surprising, because it runs principally along the bottom of the eroded gully, down which water sometimes flows. The great number of these landmarks indicates that this must once have been a much frequented route; for were it only a by-path, used occasionally, these heaps of stones would not have been built. Possibly it may have been used by pilgrims bound for Lhasa.

When looking across the desert from the termination of the Anambaruin-gol, we seemed able to distinguish clearly two parallel desert-ranges; but all this day we travelled amongst nothing but small hills, forming a labyrinth of groups and detached knots, seldom arranged in distinct ridges and chains. Their outlines are not however rounded, but the bare rock is exposed almost everywhere. Some of these groups of rocky heights are of pretty respectable dimensions, and rise steeply and abruptly from the desert, their bases unencumbered by any talus slope. It almost looks as though the transportable matter were relatively speedily pulverised by the atmospheric elements and at once swept away. And yet there would appear to have been in reality two parallel crests, for whilst crossing this desert-range, as we were then doing, at right angles, we traversed two distinctly marked passes.

Upon leaving Camp No. CXXXIII we travelled north along the watercourse which starts below the first pass, and found it grow gradually bigger as it picked up contributories from both sides. All the same, it did not appear to be the principal watercourse of the locality, for it was joined by three others from the right, all bigger than itself, and coming apparently from loftier, broader parts of this first desert-range. In the south-eastern prolongation of each of these three valleys there is a gap or notch, corresponding to a pass over the range, and far away in the same direction we could just make out, like a light flosky cloud, a snow-clad shoulder or summit of the gigantic Anambaruin-ula. From glimpses that we obtained of the country to the north-east, it appeared to be in that direction considerably lower. There were, it is true, some reddish heights; whether they were dunes or fragmentary mountains, I was quite unable to determine.

The lower part of our valley is very broad, the mountains receding on both sides, and all that remains in the vicinity of the road are small clusters of hills. At the same time the watercourse grows more undecided, its sides being only a foot high at the most. In one place a couple of sign-posts show that the road deviated from the watercourse for a little distance, and made a short cut across the flat slopes on the right-hand side of the valley. Then the steppe vegetation thinned out, and the saksaul ceased altogether. A little bit lower down the principal watercourse, and with it the valley, bends to the east-north-east, being fenced in on the right by a mountain-ridge, massive and craggy, from which short spurs jut across the valley. The landmarks indicate however, that the ancient road did not follow this main valley, but ascended a side-glen coming from the north-west. On the west side of this last there is a very imposing grey mountain-knot, the biggest and most compact of any in all that region. Here the water, a rare visitant, has scooped out ravines and deep gorges in the soft material, leaving rounded hills between. Here there was no snow; in fact we saw none all day, with the exception of two little patches in exceptionally sheltered positions. The head of the glen we were now following was overhung by lofty black cliffs, and to avoid them I struck up into a side-glen on the left, which in a quarter of an hour led us to a very easy pass, crowned with a heap of stones. For a short distance immediately below the pass the northern slope is steep and thickly strewn with gravel; but after that the surface falls away gently and gradually towards the north. On this versant the watercourses are more undecided and less plainly indicated than on the southern side of the pass. The broad valley we were following is inclosed between two big mountain-spurs, which terminate upwards in rugged pinnacles and denticulated crests, showing various shades of black, grey, white, and red; and the farther we advanced the more were their slopes buried under drift-sand, reaching a considerable distance up the mountain-side. Then our valley is joined from the left by a second valley, very similar to itself. The valleys here are open and broad, and are inclosed between barren, desolate mountains, which, like the Masar-tagh, are the last fragmentary relics of a former vast mountain system. Towards the end of the valley the saksaul appeared again, and reached 3 to 4 meters in height, remarkably fine, vigorous bushes for such a dreary region. Another bush, *jantak* (*Alhagi camelorum*), also grows there. The vegetation is however richest in the mouth of the valley, where two arms of the mountains, one from the left, the other from the right, approach one another like the claws of a gigantic crab, leaving only a relatively narrow opening between them. It is within the shelter of these giant arms that the vegetation I have mentioned is able to thrive, safely protected against wind and drift-sand. The only drift-sand that does penetrate within that stony fence has arranged itself into quite small dunes, but the slopes of the two arms are deeply buried in it. Here again at Camp No. CXXXIV we found signs of human presence in a species of temporary fireplace, made of stones, in part still blackened by soot.

We had travelled all day through granite. Below Camp No. CXXXIII it was dark-coloured, fine-grained, and greatly weathered, dipping 77° N. A little lower down it was grey, and medium-grained, and accompanied by pegmatite with similar properties, dipping 83° towards N. 15° E. Then came red, fine-grained granite with some veining, and dipping 83° N. On the threshold of the second pass the granite was dark-coloured, fine-grained, veined, and strongly disintegrated, its dip being 79°

towards S. 35° W. At the end of the day's march it was coarser and of a light red colour, and dipped 56° towards S. 5° W.; and immediately below that came marble, disposed at 49° towards the S. 35° W. The extreme left wing of the mountains consisted of coarse-grained grey granite, resembling pegmatite, and lying 74° to the S. 30° W. The rock was everywhere very distinctly bedded at the dips stated.

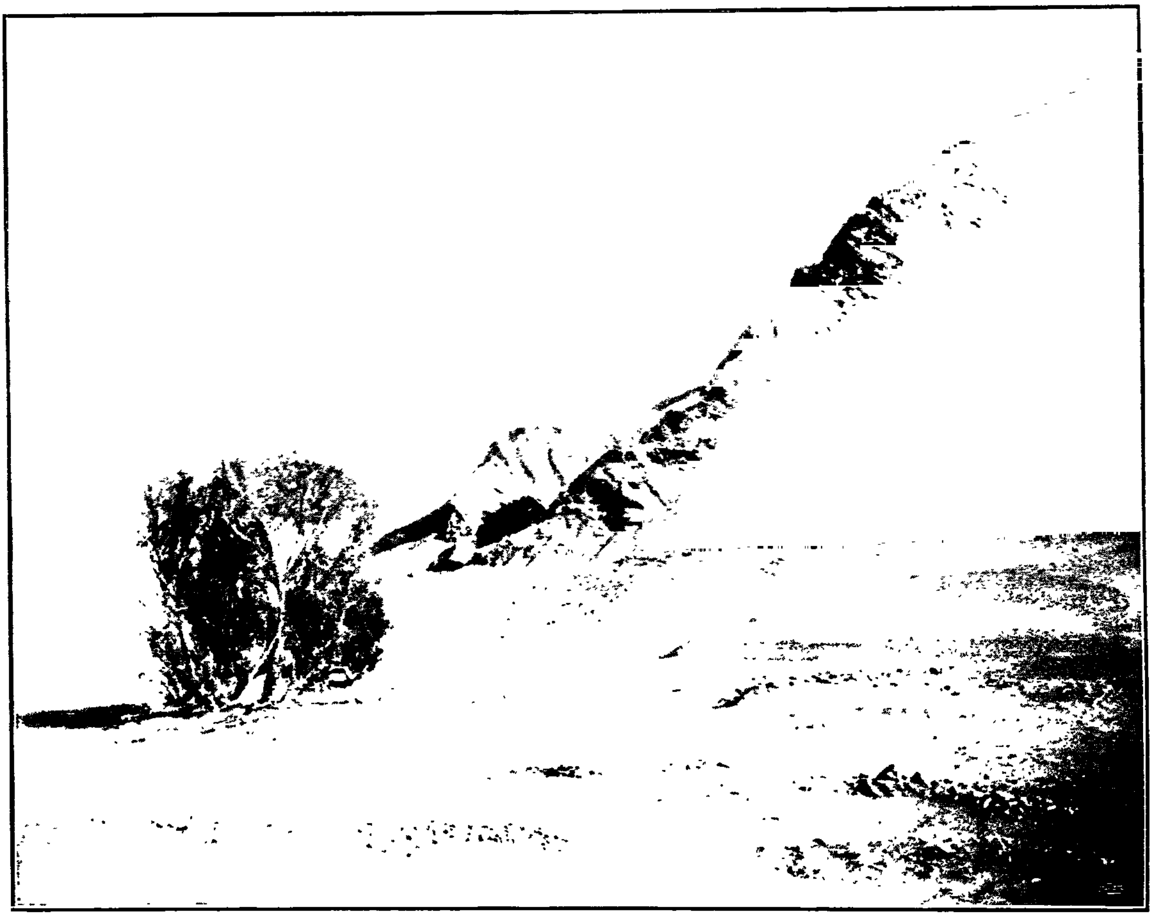
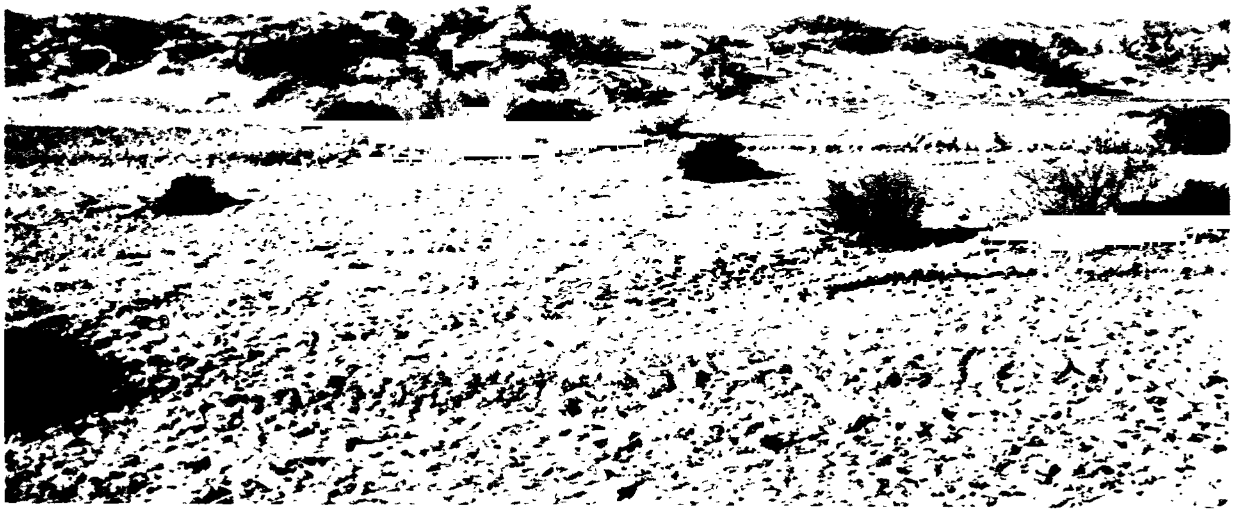


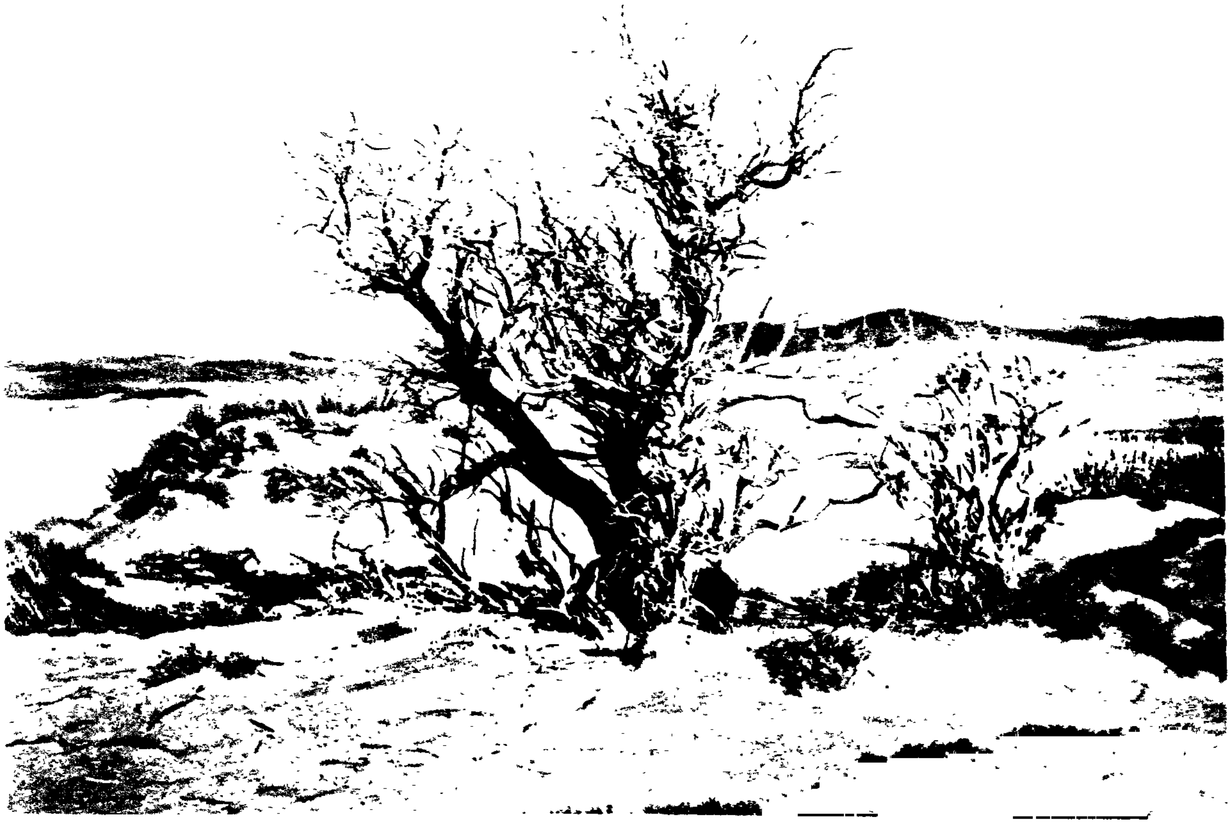
Fig. 205. RIGHT SIDE OF THE VALLEY WHICH OPENS OUT INTO THE SANDY DESERT.

This journey across these small mountains was sufficient to afford a tolerably clear idea of their general orographical structure. If they do belong, as seems likely, to two parallel ranges, then, at all events in the region where I crossed over them, they are intimately interrelated and intermingled. Littledale depicts them on his map as two separate and quite distinct ridges, running in straight lines; but he only saw them at a distance, from the south, and is thus manifestly wrong. But he was at all events the first to testify to their existence.

On both the 29th and the 30th January the wind blew from the north-west, but was more noticeable because of its coldness than because of its force, for it never once displaced the drift-sand. The sky was clear, except for light clouds in the south; but the atmosphere was not perfectly pure by reason of the dust, so that



LITTLE OASIS JUST ABOVE CAMP CXIII. FEB. 10TH 1901.



Ljustr. A. B. Lagrelius & Westphal.

SOUTHERN PART OF KURUK-TAGH.

These two views will give an idea of how little some parts of the Kuruk-tagh convey the impression of being a mountainous region.

our view across the desert-ocean, on the margin of which we once more found ourselves, was limited.

Here, where the hard rock comes into immediate contact with the light pulverised rock-material, there exists a very peculiar type of landscape. The shallow, eroded watercourse hugs closely the foot of the western »claw» of the mountains, and after sweeping round it in an arc penetrates north into the sand, describing innumerable windings. It is so closely invested by gigantic dunes that its narrow, sharply cut channel could not be observed from behind them. If, instead of following the torrent, we had travelled along the terrace-like, sand-covered heights above, at the foot of the lofty cliffs on the right, we should at once have become entangled in a chaotic labyrinth of high dunes, displaying none of the regular and favourable architecture of the dunes in the Desert of Tschertschen. The northern slope of the rocky projecting »claw» on our left was covered more than half-way up with wave-shaped dunes; and without doubt the same thing has happened all along the northern face of this desert-range. Immediately along its foot the dunes have piled themselves up to twice their ordinary height, like the breakers on a rocky coast. Smaller obstacles, such as tamarisk-mounds and poplars, are avoided by the sand, which arranges itself round them in an annular dune, a consequence of the arrest of the atmospheric current when passing the obstacle. On the sides of the mountains the effect appears to be different. Where the slope is not too steep, the atmospheric current merely deviates vertically, and thus its power of transporting the drift-sand is not checked. It might be expected that the individual dunes would indeed be able to climb up a

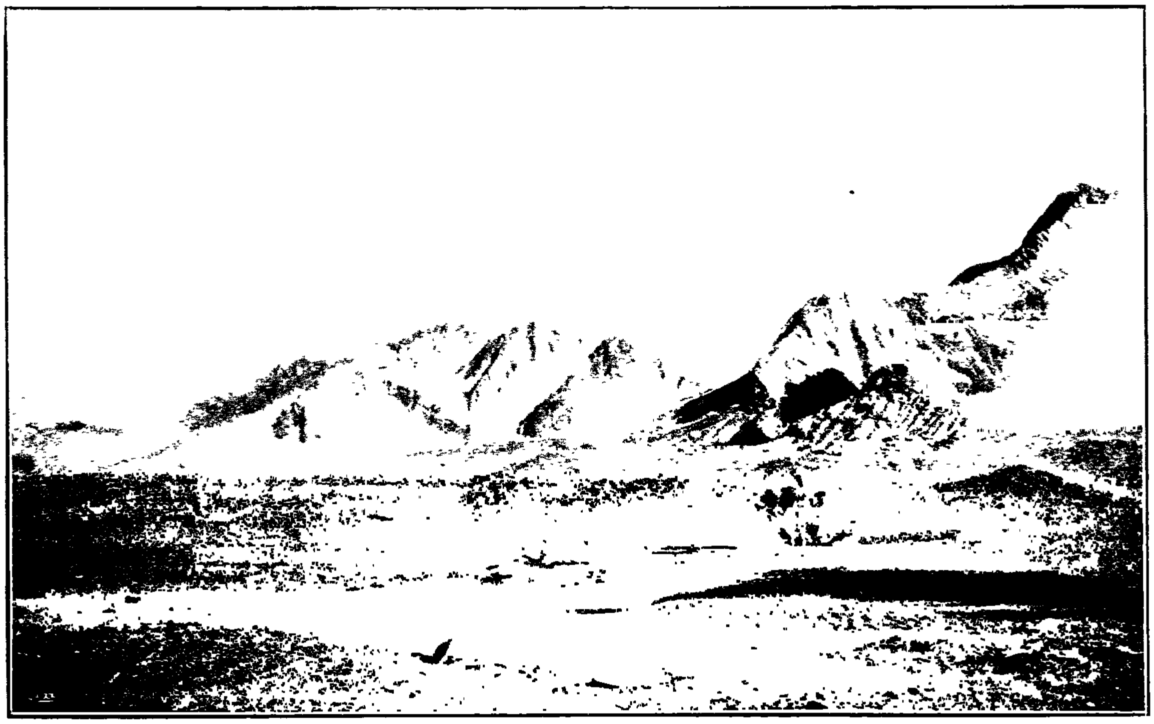


Fig. 206. ANOTHER VIEW OF THE SAME.

steep mountain-side as easily as they do up the dune-accumulations of the Desert of Tschertschen. But this is not the case; for these two mountain-arms, which are in any case not very much higher than the dune-masses of the Desert of Tschertschen, place an insurmountable barrier in the way of the invading drift-sand — a wave-breaker as it were to stop their advance. The small dunes which have drifted within them have entered direct by the rocky gateway. This goes to show, that the wind is not able to lift the drift-sand to any very great height above the surface of the earth. It is well known to all who have had personal experience of a hard tempest in a drift-sand region, that by far the greatest amount of drift-sand travels immediately above the surface of the earth, the individual grains being rolled along by the wind. It is only the lighter, smaller particles that are lifted one or two meters above the ground. The impenetrable haze which comes on during a desert storm is caused by the fine dust, which in part is already intermingled with the sand, in part is caused by the friction of the sand-grains one upon the other. Yet even this drift-dust does not ascend to any great height. In very violent gales in the Takla-makan I have observed the blue sky shining in the zenith, while in a horizontal direction I was unable to see farther than a score of meters or so.

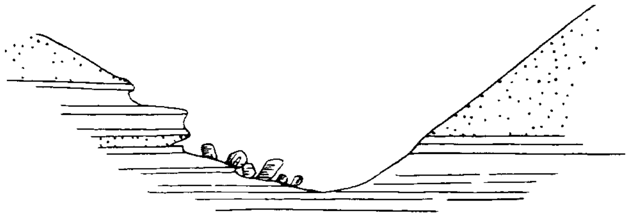


Fig. 207.

The watercourse shoots away from the mountain foot at a right angle. The dunes on both sides of it are built up for the most part in pyramidal shape. We therefore selected the bed of the watercourse as the most convenient route by which to make our way through them. Its bottom consists in part of hard, greyish yellow clay, in part of sand, and has an imperceptible fall towards the north. But in places, even in the bed of the watercourse, the original soil is to some extent sanded over, though the coating is extremely thin. Here, from the convex elbows of the bed, there project flat tailing tongues of sand, corresponding to the alluvial peninsulas in a river, and not seldom they stretch right across the bed. On the opposite side, answering to the deeply penetrating concave sweeps of a river, the dunes rise as steeply as they can to their full height. Nothing but running water could keep such a path open through the sand-field; that is the reason why we have here all the characteristics of an ordinary river-bed. It looks as if the watercourse avoids the biggest of the dune-accumulations, and gets out of their way, for though it does, it is true, penetrate at every bend into the high sand, it at once swings out of it again, and crosses over to the opposite side, where it again curves. Hence it is quite natural, that the river, through its erosive energy, operating at the foot of the sand, should preserve a steep face to the dunes. But a similar undermining process does not attack the convex bank: there the sand is flatter.

The profile of the bed of the watercourse is generally V-shaped. Consequently its bottom is extremely narrow, so narrow in fact that there are not many places in which two camels can pass one another. Almost everywhere the sharp-cut edges of the clay erosion-terrace project through the sand, in places quite distinct, in others only adumbrated as it were; but throughout they are as sharply determined as though they had been cut with a knife. They run 1½ to 2 m. above the bottom of the water-course. The material is clay. Very often they form projecting cornices, strewn with coarse sand. This formation would appear to originate in this way: layers of clay and sand are disposed one upon the other, and then the superimposed layer of clay, offering greater resistance than the underlying sand, is left hanging without support. Every now and again, however, these overhanging cornices break off; for in various places we found their crumbling remains littering the bed of the water-course.

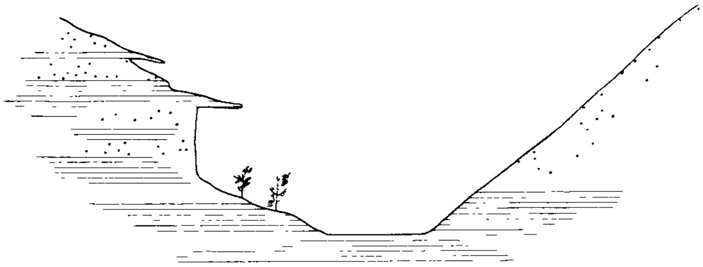


Fig. 208.

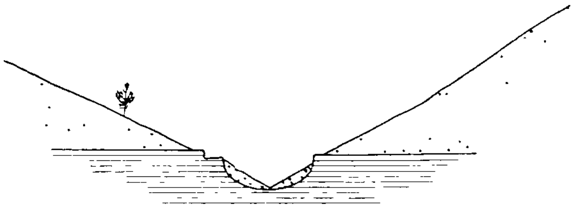


Fig. 209.

But nowhere did we observe any indications that water had recently flowed down that way, and the bottom was of course as dry as tinder. Nor do the sharp-cut edges of the original erosion channel remain, for the terraced banks, of which I have just spoken above, are higher than the original edges, and have been produced in part by the crumbling away of the original edges, in part by the erosive action of the wind. Nevertheless this remarkably clear-drawn hollow through the drift-sand is alone sufficient to prove that, at intervals of perhaps five or ten years, water does flow down from the northern versant of the little desert-range, and it must be after short, but sharp, showers. Did the winds blow here with the same regularity that they exhibit in the Desert of Tschertschen or the Desert of Lop, such a narrow channel as that would not be able to keep itself open so long, but it would be filled up by sand coming from the direction of the prevailing wind. So far as I was able to ascertain whilst crossing that part of the desert, the winds there are indeed locally less regular and more variable. And yet the region must be visited by violent storms, only they blow rather from the west and west-north-west; at any rate it was from that direction that they had come last, for most of the dunes turned their leeward slopes very decidedly towards the east and east-south-east. Probably the wind blows predominantly from that direction in summer, autumn or winter, for in spring this region is presumably subject to the predominance also of the east-north-east wind, and then the dunes turn their leeward faces in the opposite direction. This is the reason why there exists no regular uniform relief, but instead a chaos of dunes, nowhere interrupted by bajir-depressions. It is close in under the mountains that the dunes exhibit especially fantastic shapes, the result of the divergent effects produced upon the direction of the wind by the projecting, irregular flanks of the mountains.

Quite naturally too the watercourse is most distinct and most sharply outlined close to the mountains, where the sand is swept cleanest away; and as we advanced towards the north the channel became increasingly less distinct, while at the same time the sand obtruded into its bed in the form of small transverse tongues or thresholds. Whenever it rains amongst these mountains, the resulting torrent must be extraordinarily turbid, seeing that it is forced to concentrate all its erosive energy within that narrow rocky gateway, out of which it must therefore sweep every particle of transportable material. But in proportion as the torrent advances farther and farther away from the foot of the mountains, it gradually loses a great part of its water, which is absorbed by the thirsty clay and sand, so that its volume continually diminishes. The torrents from even slight rains get down to, and out through, the rocky gateway, but it is only the heavier showers which propel them into the desert beyond.

The saksaul bushes still continued to appear singly at the sides of the watercourse, often half buried in the sand, and many of them were already dead. Here too there occurs a dry desert plant known as *schap*. The corners and angles were often full of portions of dry plants, blown there by the wind. The signs of wild-camel, which were extraordinarily numerous in the desert-range, had by this entirely ceased. The animals no doubt fight shy of such a narrow passage-way, where they are unable to see all around them, and consequently are more liable to be surprised. And the same thing is true of the tracks of antelopes; for they too were plentiful in the mountains, but were absent down here. On one slope we observed a small pyramid of stones, though it was impossible to make out whether it had been put together by human hands or whether it owed its existence to pure chance. In two or three places there were blocks of granite and quartzite, a cubic foot big, lying on the surface of the sand. Even so small an obstacle is avoided by the sand, otherwise these blocks would have been covered up with it. Strange to say however, there were no annular accumulations of sand round them, the consequence no doubt of changing winds and wind-eddies. The stones lay as if they had been placed where they were by a gentle hand. This recalls the endeavour of glacial ice to free itself from the solid materials that chance to get entangled in its mass.The observation applies however only to those slopes of the dunes which are exposed to the wind, for any object lying on the leeward side is of course bound to be buried under the sand.

Then the sand grows lower and lower, and the edges of the clay project more and more, while at the same time the country becomes more open. The nearest dunes appear to be little more than 10 m. high; but farther on there are pyramidal dune-accumulations, which, to judge by the eye, attain altitudes of 60 and even 80 m. At the same time the watercourse makes a decided turn towards the north-west, and then runs in an almost straight line, without even the slightest bend. Here there was an abundance of saksaul bushes.

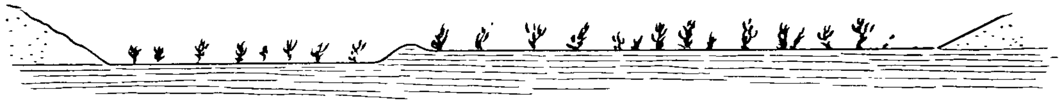


Fig. 210. THE DEPRESSION WITH A RIDGE IN THE MIDDLE.

At length the watercourse comes to an end altogether, terminating in an open arena, a sort of expansion of its extreme tentacle. Although hemmed in by vast masses of sand, the bottom of the arena consists of hard, yellow clay, with a few small tongues of sand shooting out into it. This expansion evidently fulfils the same function as the terminal lake of a desert stream. Whenever a strong current comes down the watercourse, it must form in this basin a small, but extremely transient, lake, or rather a rapidly drying salt-marsh. This was no doubt often the case formerly, and what now remains is the last surviving relic of a terminal lake, and it is inevitably doomed to be obliterated by the drift-sand. Saksaul bushes grow there more luxuriantly than anywhere else, the seeds having been carried down by the stream. The depression is elliptical in shape, its long axis stretching from south-east to north-west, about 1 km. long and 300 to 400 meters broad. In its south-east half there is a low swelling or ridge, likewise running from south-east to north-west, and the part of the depression which lies north-east of it is about $^3/_4$ m. higher than the part to the south-west of it. It is in fact a terrace-like step, or rather the right erosion-terrace of the watercourse, and it does indeed form a direct continuation of the actual erosion terrace (fig. 210). It proves unmistakably, that formerly, when the rainfall of that region was more plentiful, the stream used to push farther towards the north-east than it does now, and that in the course of time its lower course has become sanded up. The stream has drawn itself back in proportion as the climate has become more arid, and the disintegration of the desert-range has advanced, the quantity of the sand increasing simultaneously. The depression I have just described marks its present maximum extension towards the north-west; but it is clearly a long time since any water got down even as far as that. The saksaul still fight manfully to maintain themselves alive, but the numerous decayed examples betray that it is as much as ever the roots can do to penetrate downwards to the ground-water. The last portion of the eroded watercourse, as well as the orientation of the depression, indicates that the ground has an unmistakable slope towards the north-west, that is towards the basin of the Lop-nor, which is thus the lowest level not only in the basin of the Tarim, but also of this eastern desert region. The shortest stream-line of the region, and it is coincident with the continuation of this watercourse, would undoubtedly terminate in the Kara-koschun. Nobody will, I suppose, maintain that this miserable and extremely rare stream has anything to do with the origination of the Desert of Kum-tagh, the north-eastern part of which it crosses? It is not the river which, during a former period of more abundant precipitation, provided the materials for the formation of the dunes, but on the contrary it is the dunes which have destroyed the entire lower reaches of the watercourse; and within a brief period they will also overwhelm the remainder of it, all the way up to the mountains.

# CHAPTER XXXIV.

## FROM THE DESERT RANGES TO THE KURUK-TAGH.

At the north-western extremity of the arena there is a steep dune-wall, 4 m. high; but it was the lowest spot at which we were able to ascend to the connected, compact sand above. Indeed the sand is so compact that it nowhere furnishes the slightest break, nor does it show even a rudimentary trace of bajir formation. The saxaul plants still stuck up however here and there through the all-engulfing sand, while a few solitary *schap* plants clung to its surface; but very soon all vegetation came to an end, and there was nothing but the absolutely barren desert stretching before us. Even then the arrangement of the dunes was rather irregular, for we failed to observe more than two or three relief-forms that recurred with anything like frequency, e. g. a leeward slope just under the crest of the dunes, and facing east, though that was not particularly well developed. This pointed to the prevalence of a westerly wind during the last preceding windy season. But above that sea of sand there rose dunes of considerable size, beautifully shaped like dolphins' backs or rounded ridges. As a rule these stretched N. 20° to 30° W. and were separated by tolerably level strips of flat sand, crossed, but at wide intervals, by occasional connecting dunes. We marched therefore for the most part in the direction just indicated. In this desert too there occur not infrequently pyramidal dune-crests, dominating their surroundings and visible for a long distance. In two or three places we saw the tracks of wild camels, from which I inferred that these animals cross the desert to and fro between the desert-ranges I have been speaking of and the Kuruk-tagh. Although the sand was heavy, our march was rendered somewhat easier from the slope of the surface being with us (Pl. 46).

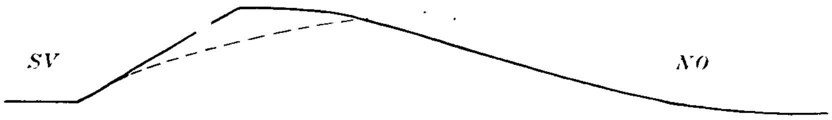


Fig. 211.

On the 31st January the wind blew from the south-east in the morning, but soon veered round to the east and north-north-east: but it was too feeble to move the sand. In that part of the desert the dunes presented generally the following profile (fig. 211), that is to say, during the spring and summer the north-east wind disposes the dunes in the same way as in the Desert of Tschertschen and the Desert of Lop, with their leeward faces towards the south-west, but during the autumn and winter the prevailing wind blows from the west, so that the steep leeward faces look towards the east and north-east. But the latter wind is less powerful than the former, the consequence being that the latter leeward slopes are shorter than the former. Owing to the effects of the south-west wind the eastward-facing slopes have lost a good deal of their sharpness of outline, and their steep flanks are more rounded and »lumpy».

In the parts of the Kum-tagh which still remained to be traversed the distribution of the sand was extremely peculiar und unusual. It formed a passage-way like a river-bed 600 to 1000 meters broad, and situated between huge ridges of sand, which, like the »bed» itself, stretched towards the north-north-east. In fact it reminded me of a bajir completely choked up with sand, although that was the only feature in which it had anything in common with such a formation. (See the upper photograph on Pl. 49). Especially interesting were the transverse dunes which ran across this »bed» or gulley. They were on the whole drawn out between the west-north-west and east-south-east, and formed tiny crests about 2 dm. high; and although they were exceedingly easy to cross, yet by reason of their vast numbers they somewhat retarded our march. As a rule it was impossible to determine which slope was the steeper; perhaps the superiority in this respect lay with that which faced north-north-east, the south-west and west winds having been the last to blow. The distance between the separate crests amounted generally to between 3 and 4 meters. In some places along this gulley the wave formation was less distinctly marked, or entirely distorted owing to the irregular winds. It was therefore no longer possible to determine whether the wave-lengths increased or decreased in the direction in which we were travelling. One thing however appeared to me to admit of no doubt whatever, and that was that these small transverse dunes were nothing but ripple-marks, which from an insignificant and minimal beginning had grown up into small dunes, so that they thus constituted an intermediate form between ripple-marks proper and completely developed individual dunes. The gulley measured about 4 km. in length, so that there was ample room for ripple-marks to grow to even bigger dimensions than actually is the case even in the largest dunes. This would undoubtedly be the very place in which to study the development and growth of ripple-marks, for with the wind blowing hard from the north-north-east or the south-south-west the circumstances and the lie of the ground would be especially favourable. Their delicate patterns are however soon destroyed by winds from other directions.

Meanwhile the projecting offshoots from both sides decreased in height, until finally they ceased almost entirely. A little to the west of our route the sandy desert continued northwards for the rest of the day's march, and although the dunes decreased in altitude, and at the same time grew more irregular and uneven, still lofty pyramidal summits continued to show themselves at wide intervals. I feel pretty certain, that the Kum-tagh broadens out towards the west, where in several places it reaches to the wells that dot the desert-route between Abdal and Sa-tscheo. Our route however crossed the desert at a comparatively narrow part, not more than 1½ day's journey across. Farther towards the east-north-east it either tails away altogether or else is connected with the sandy expanse at Tung-huan, which Loczy has described. What the country looks like in the region where this sandy desert comes into contact with the low foot-hills of the Astin-tagh, that is north of the route followed by Littledale, is absolutely unknown; for the Kum-tagh has never been traversed by any traveller except along the line which I am now describing.

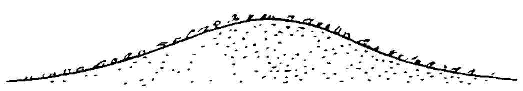
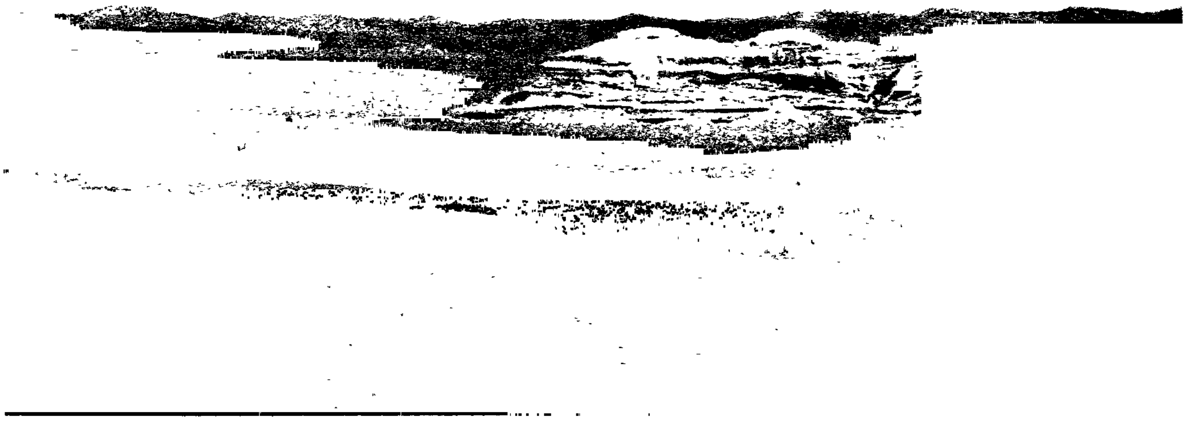


Fig. 212.

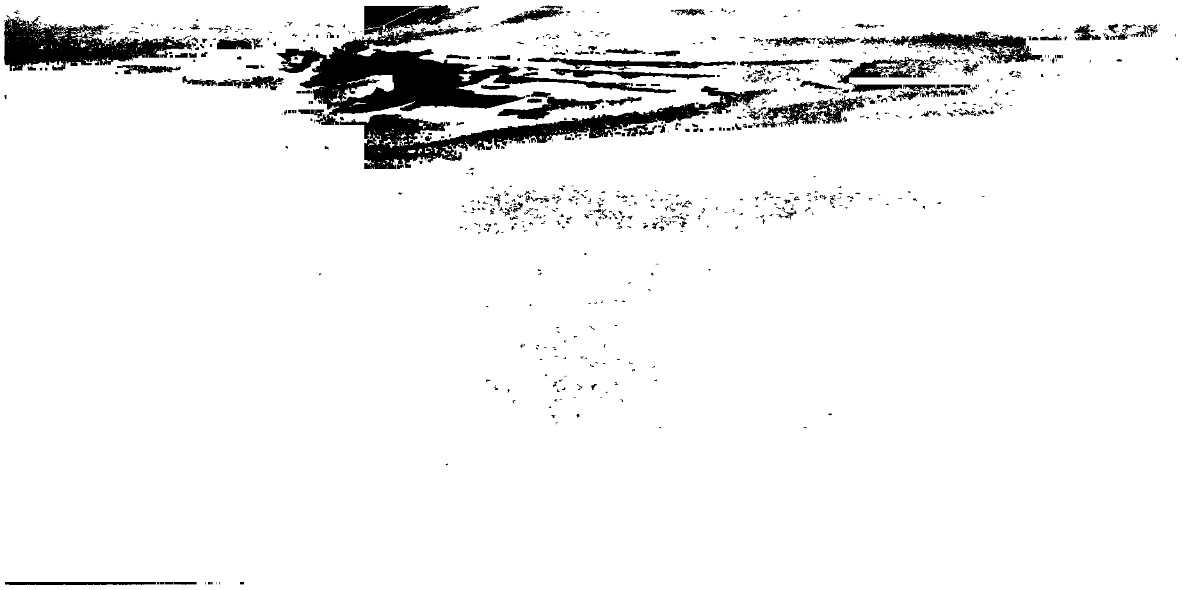
After the sandy desert has thus thinned out and died away, another characteristic and peculiar type of landscape presented itself. The surface, consisting of hard, yellowish grey clay, fell away very gently towards the north, though not in one level, unbroken slope, but by terrace-like steps and platforms, the flat table-like surfaces of which were covered with a thin layer of coarse sand or fine gravel, out of which the finer, lighter material had been blown. Between these terraces, thus jutting out like fingers, capes, and promontories, the above-mentioned sandy gulley still continued to show itself, although now, instead of being inclosed by sand, it was bordered by stretches of clay hills; and its bottom still continued to be strewn with a thin layer of hard, coarse sand. This peculiar relief explains the origination of the level, bajir-like passage through the sand. No doubt the portions of the passage that are now free from drift-sand will some day likewise be overwhelmed with it, and the sand will then of course have to adapt itself to the conformation of the original surface. The passage does not fall in steps like the terraces, but has a tolerably regular and uniform slope; in fact it almost resembles an old river-bed, though it has in no sense whatever been caused by the action of water erosion. It runs towards the north-north-east and north-east, and hence makes for the Chara-nor rather than for the Lop-nor. In places we passed small shallow depressions, in others elevations, so that the surface undulated to some extent. One characteristic feature of the gulley was a number of low, hard ridges of gravel, stretching diagonally across it from south-west to north-east; several of these we crossed over. The layer of gravel appeared to be only superficial, for the interior consisted entirely of soft material (fig. 212). One would be tempted to look upon them as old marginal ramparts, were it not for the difficulty of understanding, on that ground, the origin of the cone-shaped eminences, of precisely the same materials, and with precisely the same vertical section, which were scattered about in no sort of order. I confess I was unable to account for their mode of origin, unless they possibly have something to do with the desiccation of the Central Asian Mediterranean. Generally speaking, gravel is not at all rare in the gulley I am describing, even though it be nothing more than a thin sprinkling.

For a distance the step-like terraces grew smaller, but towards the end of the day's march they again reverted to their former magnitude, and again turned their steep faces towards the north-east. Some of these rose 12 to 15 m. above the level

Pl. 54.



GIGANTIC MASS OF BEDDED CLAY IN DESERT BETWEEN CAMP CXXXVIII AND ATSCHIK-KUDUK. FEB. 5TH 1901 (SEE I. 493).



*Ljustr. A. B. Lagrelius & Westphal*

CLAY TERRACES ON RIGHT OF OUR ROUTE BETWEEN CAMP CXXXVI AND CAMP CXXXVII. FEB. 1ST 1901

ground, and others appeared to be even higher still. Vegetation was entirely absent, nor did we see any heaps of stones indicating the continuation of the road we had followed in the little desert-range. The only traces of existence in those dreary wastes, where man never sets his foot, were the tracks of wolves.

On 1st February there was a pretty fresh breeze from the east, the sky was clouded over, and the air full of fine drift-sand, the dark, depressing haze obscurring all contours and swallowing up everything in one confused grey blurr at a distance of only 2 km. This was the third winter in which in these desert regions I had found the atmosphere impure and charged with dust. In the forests of the Kerija-darja the atmosphere was calm, and in the Desert of Tschertschen the wind was generally not very strong, whereas here, in the Desert of Gobi, the wind blew pretty hard. The dust-charged atmosphere was common to all three deserts. Undoubtedly a vast quantity of dust must be transported westwards from these regions. The winters which I spent in the extreme west, in the vicinity of Kaschgar, were remarkably quiet, and the atmosphere was consequently purer.

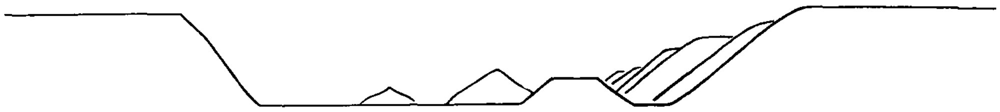


Fig. 213.

During the course of the day's march the characteristic type of landscape I have recently mentioned assumed an even more fantastic appearance, and the sand more imposing dimensions, than on the preceding day. The gulley, which we still continued to follow, was outlined with extraordinary sharpness and distinctness, and its bottom was as favourable as could be desired for marching on. There was now scarcely any sand visible, except the thin layer of coarse sand in the bottom of the gulley, where it still continued to form small transverse waves running from north-west to south-east. The slope of the bottom of the gulley was no longer gentle and uniform, but descended by steps. Only a very short distance from Camp No. CXXXVI we descended a steep terrace about 20 m. high, and after that the surface appeared to rise up gently towards a fresh ridge strewn with fine gravel, on the other side of which we again found a steep descent; and so on time after time. The terrace-wall that shut in the gulley on the right was especially high. But even in the hollow between the high bordering terraces there were minor isolated elevations, flat-topped or table-shaped (*horst*). In vertical section the country was like fig. 213. The bordering terraces were here as much as 20 to 30 m. high. Upon climbing to the top of one of these, it was easy to see that it was not a lonely and easy gulley we had stumbled upon by mere chance, for there were a number of similar gulleys stretching east and west for as far as we were able to see. The number of terraces and offshoots of this description, all extending towards the north-east, was indeed endless, and they all ran parallel to one another. The slope was now quite perceptible, and as it inclined in the direction in which we were marching, it made it so much easier for the caravan. Now in the hollows between these terrace-like elevations there are nowhere any evidences of flowing water. It appeared never to rain there; at all events all traces of the last shower that fell, whenever that was, had totally disappeared. Here too, as in the Desert of Lop, it is possible to distinguish three different stages or storeys, though the third and highest is less general than the two below it, and only occurs intermittently. It is the middle stage that predominates, and it was that which bordered the depression we were marching along. The terrace-wall was, as I have already observed, highest on the right, but even there it did not form anything like a continuous wall, but was pierced at intervals by small side-ravines, evidence, apparently, that it *can* indeed rain in that region, for these side-ravines were unquestionably erosion-trenches, and entered the depression at an acute angle. The lowest storey is rarer, and forms small detached tables or cones scattered sporadically over the hollow between the two bordering terraces.

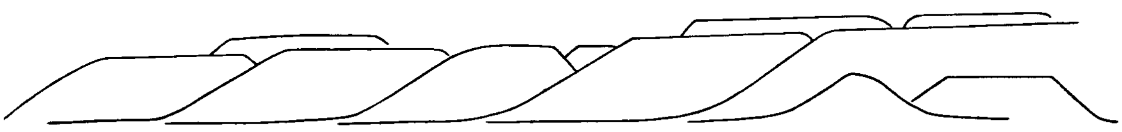


Fig. 214. SIDE-RAVINES OPENING THROUGH THE CLAY HILLS.

The question now arises, how did this interesting type of landscape originate? Is this long, distinctly marked gulley the result of ancient erosive action, a continuation of the gorge cut by the same agency through the southern part of the sandy expanse, and extending all the way from the termination of the transverse glen through the desert range? That, it will be remembered, made in the lower part of its course a distinct bend towards the north-west, whereas this gulley inclines towards the north-east; moreover the last-named presents quite a different appearance and is incomparably bigger in every way. This precludes, then, the idea of former erosive agency, more especially as there are no other indications pointing to the same cause.

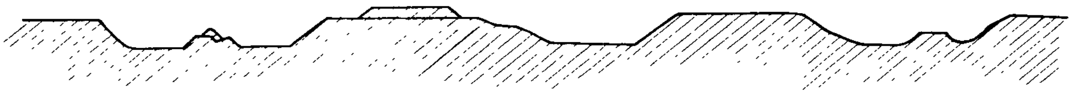


Fig. 215. PROFILE THROUGH SOME CLAY HILLS.

And in point of fact the cause of this pregnant conformation of the surface is quite different. We have here identically the same phenomenon that we have already studied in the Desert of Lop. It is the wind which has modelled the relief. Loczy observed an exactly similar phenomenon, though of course on a much smaller scale, in the north-west of Kan-su, and he accounts for it in precisely the same way that I do for the phenomenon here. He says, »Ebenso erweisen sich als Resultate der Arbeit des Windes jene oben gerade abgestumpften 0,80—1,00 Mtr hohen Lösshügel, wie sie am Rande der Lössgebiete, wo dieselben das Kiesfeld überlagern, am häufigsten zu beobachten sind. Die Entstehung dieser Hügel, deren Steilseiten dem herrschenden N- oder NW-Winde zugewendet sind, ist augenscheinlich folgende: Der über die Sandwüste dahin treibende Sand greift die weichen Lössrideaux an und schneidet in dieselben Furchen ein, aus welchen der Wind den Löss bis zur Kiessohle herab wegbläst und als feinen, trockenen Staub durch die Lüfte führt; auf diese Weise wird die Lössdecke, wo dieselbe durch die Vegetation oder Feuchtigkeit nicht geschützt ist, schrittweise von den Kiesfeldern weggeblasen, bis schliesslich als Reste der einstigen Lössdecke solche Lösshügel zurückbleiben.»*

Exactly the same thing takes place here. These are the jardangs and wind-eroded gulleys of the Desert of Lop, though on a larger scale. They all run parallel to one another, namely from north-east to south-west, and consequently have been subjected to the modelling influence of the same north-east wind that shapes the features of the Desert of Lop. In this desert we found that the differences in level between the top of the jardangs and the bottom of the gulleys was greatest in the north, and that it decreases towards the south, until in the vicinity of the Kara-koschun the surface is virtually level. Here again, in this part of the Desert of Gobi, the difference in elevation between the terraces and the depressions decreases towards the south. In both deserts the shallower gulleys disappear under the drift-sand, which is augmented by the sand particles that the wind sets free and adds to the dunes it forms. The sand would no doubt have accumulated in its present position even though the underlying surface had been a plain, with a uniform slope; but on the other hand the presence of the sand is possibly the cause that these wind-eroded gulleys are not so deep, and that they are most developed in those parts of the desert in which no dunes exist.

The fact that the dimensions of these surface irregularities are so much greater in this more easterly desert than in the Desert of Lop may be thus accounted for. A certain limit is imposed upon their development in the latter desert by the migrations of the Lop-nor, which levels down and smooths away all the irregularities of the surface, whereas in the former desert there have not been any similar inundations to effect a like levelling process.

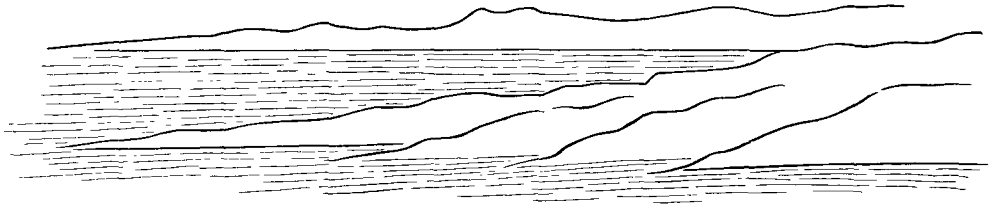


Fig. 216. CLAY HILLS RUNNING OUT INTO THE DESERT.

But just when these terrace-formations reach their highest altitude in the Desert of Gobi they suddenly come to an end. The left-hand bordering terrace disappears towards the north-west; but from that on the right we diverged more slowly owing to our route running north-east. In the mouth or termination of this long trench there are some solitary detached table-like masses of clay, with small level patches between them overgrown with kamisch and other steppe vegetation. Then, after a short stretch of sterile soil, we came to the kamisch steppe, the reeds being more or less dense, while the ground on which they grow is soft, consisting of sand and dust, with only an occasional patch of hard schor. On this apparently quite level expanse there does not exist one single table-like elevation of clay. The line of division between the terrace country and the steppe country is therefore very sharply drawn, and there is a very appreciable difference of altitude, so that in going from the former to the latter it is like stepping down a brae. At the same time the inference forces itself upon you, that at some epoch or other this boundary coincided with the dividing-line between land and water, or in other words that the distinctly marked front of the terrace-formation was once the containing shore of an inland lake, the bottom of which was identical with the existing level steppe.

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* *Wissenschaftliche Ergebnisse*, etc., vol. I p. 507.

At Camp No. CXXXVII the kamisch was rather thick and vigorous, and there too we observed two or three tamarisks growing. Upon digging a well, we obtained water at a depth of 1.14 m., which, although slightly salt, was nevertheless drinkable. The water rested upon a clay formation, but we had to dig down through sand to get at it. The temperature of the ground at a depth of 25 cm. was — 0.7°, at 50 cm. + 1.0°, at 75 cm. + 2.5°, and at 114 cm. + 4.51°.

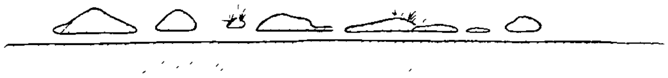


Fig. 217.

On the second February a stiff gale from the east seemed to indicate that the characteristic spring storms from that quarter had already begun. Immediately north of the camp we discovered a very distinctly marked path through the kamisch, running towards the west-north-west, and the footprints and droppings of wild-camels soon revealed that it had been made by those animals, and not by men, for indeed human beings never visit these desolate regions. Another wild-camel track, which we subsequently crossed over, ran towards the S. 80° W. Shortly after that the kamisch and other vegetation thinned away, and was followed by a perfectly barren tract, which we crossed towards the north-north-west. It was in part perfectly level, in part rugged, semi-hard, the surface being covered with a thin layer of wind-driven dust. After that the schor surface became slightly moist on the top and assumed a dark brown colour, while at intervals were small strips of the vanishing kamisch. After that we traversed a narrow zone of dead toghraks, a couple of meters high and a foot in diameter, merely dried up, contorted trunks, scattered rather thinly and standing some on the level ground, some on small conical elevations. Except for one solitary specimen, which appeared to retain just a spark of life, all the others were but »relics of a vanished past«. Nevertheless every one was still standing upright on its own roots. The surface there was gently undulating, and consisted of sand and dust intermingled. Then, after a belt of similarly dried up tamarisks, the standing poplars again made their appearance, as also kamisch. The former were thinly scattered, but in some of the smaller depressions the kamisch was quite abundant. In one of these depressions, which was surrounded by sand-dunes 1 to 2 m. high, we made Camp. No. CXXXVIII. When seen at the distance of only one km. the sand-dunes had, owing to the mirage, quite an imposing appearance, seeming to be disconnected from the ground and to be hovering in the air. All day we saw at the distance of about 4 km. to the west a stretch of hills, apparently a continuation of the left-hand terrace already described. In the same direction there were also a few solitary dunes occurring at intervals. Both deserts, the sandy desert and that of the clay terraces, were considerably broader in the west than along the line where we crossed them.

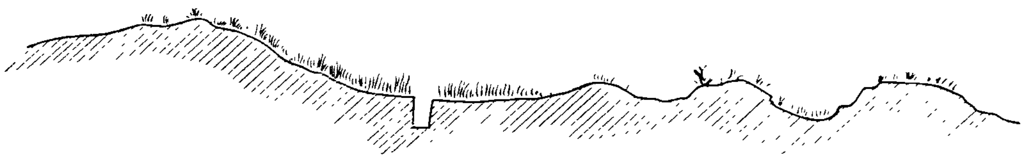


Fig. 218.

Here again we dug a well; and while the temperature of the air was — 1.6°, the temperature of the ground at the surface was — 0.95°, at 25 cm. — 0.53°, at 40 cm. — 0.40°, at 59 cm. + 0.22°, and at 84 cm. + 2.22°. The ground was frozen as hard as a stone to the depth of 55 cm., and the water, of precisely the same character as in the last well, was met with at a depth of 84 cm. The principal reason that the ground here was frozen to a greater depth than at the preceding well was that we dug it at the northern foot of a little sand-hill, where the shadows remained longer (Pl. 56). The water trickled out in some abundance, though slowly; and the areometer indicated a sp. gr. of 1.0065.

From this camp we were just able to make out faintly the mountains on the north as well as those on the south. In the latter direction we inferred rather than actually saw the sandy desert from the light yellowish glare which vibrated above its surface. On the 4th February quite a stiff westerly breeze blew all the afternoon.

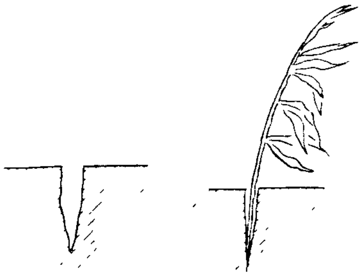


Fig. 219.

In the sandy ground we frequently came across vertical holes a couple of decimeters deep. We soon ascertained what was the cause of these, for in some of them we found stalks of kamisch, with all their leaves on, still remaining. When the wind starts swaying the stalk to and fro, the part which is fast in the ground gradually enlarges the socket in which it stands, until finally the stalk breaks off at the root, and leaves a gaping hole behind it. Almost every individual kamisch stalk, after being bent to the ground by one or other of the different winds, had described on the sand or on the schor as many concentric circles round its base as it possessed leaves. Although seldom more than half complete, and seldom distinctly marked for more than half-way round, these rings are gradually deepened by the hard, sharp points of the leaves (fig. 220). How the future geologist would puzzle his brains to explain the origin and meaning of these regular geometrical circles if he came across them on the horizontal face of some bed of sandstone!

On the 5th February we travelled nort-north-west and north towards Atschik-kuduk, passing on the way the following configurations and arrangements of the ground. The gently undulating surface grew level again or was slightly lumpy schor, somewhat moist on the top, with rapidly thinning kamisch. Then followed a belt of rounded tamarisk-mounds, 1 to 3 m. high, carrying dried up tamarisks. Almost all the kamisch we saw there was dead, and occurred in small isolated patches. Afterwards the mounds grew more numerous, and some of the tamarisks on them were still living. There were also a couple of dunes of hard, coarse sand, not more than 3 m. high, but despite this fact they appeared to be stationary. They extended from north-east to south-west. North of them was a shallow, indistinctly marked bed, running from east to west; it was in fact partly obliterated, and probably owed its origin to some local, but exceptionally violent, shower of rain that fell in the desert. North of this again were a number of tamarisks, mostly living, and standing partly on the level ground, partly on small mounds. The surface there consisted of a thin, loose crust of grey schor, resting upon sand, and so brittle that it crumbled to pieces when trodden upon. Belts of tamarisks and kamisch extended westwards as far as the sandy desert, a distance of about 7 km.

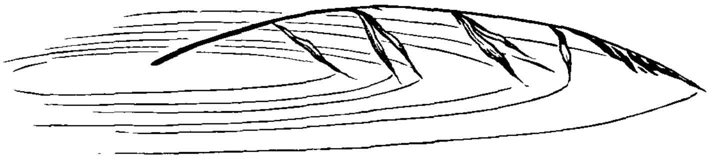


Fig. 220

Shortly after that we reached the sharply defined edge of this area of vegetation. It was like the shore of a lake, and beyond only a few solitary tamarisks, or small groups of tamarisks, dotted the surface like islands and holms. The ground too was very hard, and was covered with fine gravel, and so it continued for as far as we could see towards the north-east. Embedded in this sterile *saj* lay a large island or oasis of kamisch and tamarisks, the gravelly soil being raised above it all round like a bank; and in the middle of the oasis was a still smaller depression, showing a level, white schor surface. To the east we perceived two or three solitary table-like elevations of clay. On the whole, judging from such tiny water-channels as there were, the surface appeared to slope towards the north-west. One of my men, who reconnoitred the country to the west, reported, that immediately before reaching the sandy desert he came to a marshy region, into which a few small watercourses gathered, and which some time or other must have formed a small temporary lake or marsh.

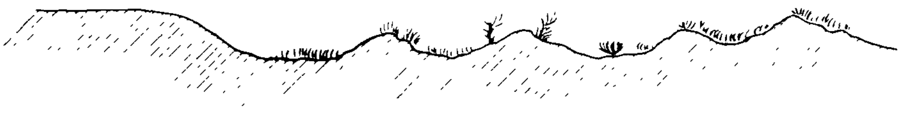


Fig. 221. VERTICAL SECTION OF A LITTLE KAMISCH ISLAND IN THE DESERT.

On the other side of the oasis the hard gravelly soil again made its appearance. We also passed on our left yet another similar small oasis, to the south of which, and stretching westwards, was a narrow strip of white level schor. The western sand now began to close in upon us. The country still presented the same appearance as before, that is it was arranged in terraces and tabular masses. One such mass, which stood quite alone, resembled a gigantic yellow-washed ruin (Pl. 54). It was built up of an endless number of horizontal layers, varying in consistency, but all containing large percentages of sand. It appeared to stand on the hard, level ground and to be almost detachable from it. Immediately north of it we entered a belt of high sand, or else an offshoot from it. The dunes were, it is true, not more than 15 m. high, but they were irregular and difficult to travel over. Most of their crests seemed to stretch S. 53° W., with their steep faces turned towards the north-west, though in other individual dunes the leeward versant was turned more directly towards the west. On the other side of this belt of dunes, we found that the connected sand advanced quite close to us on our left, though to the east its contours were lost in the far distance. The surface still consisted of sand arranged in long, gently swelling undulations. In places the hard, coarse sand was covered by a thin layer of small, round polished stones, not bigger than peas and all of the same size. Although they lay as close to one another as it was possible for them to do, they were all in one plane, none were piled upon the others; yet they were quite sufficient to prevent the underlying drift-sand from moving. In a few places there were solitary dunes resting upon this substratum.

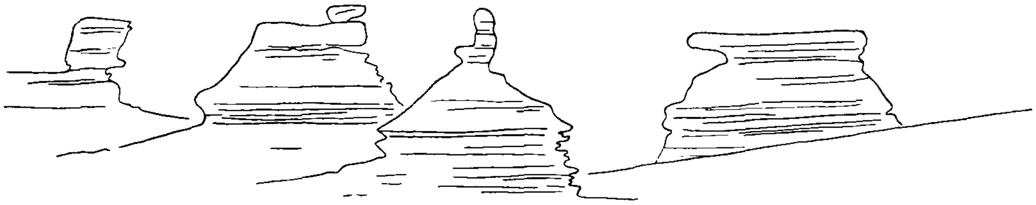


Fig. 222.

Then came yet another belt of clay terraces, exhibiting strange, fantastic outlines (Pl. 55); my men compared them, and correctly enough, to the surviving cupolas and mosques in an otherwise destroyed town (fig. 222). They are 7 to 8 m. high, and consequently are lower, as well as more scattered, than the similar formations we saw below Altmischbulak. I broke to pieces several of these soft and easily crumbled masses of clay; but, notwithstanding the evidence which their regular horizontal bedding affords, that they were deposited in water, I never succeeded in finding any tracesof organic life in them. The belt of sand extended 10 to 15 km. to the north-east, where its termination was distinctly visible; the intervening space was occupied by sporadic dunes and tabular masses. Beyond a series of clay tabular masses, with gigantic portal-like openings between them, we caught glimpses of a couple of yellow expanses of kamisch, and from the top of a lofty dune I observed a third, which my guides announced to be Atschik-kuduk, or the Bitter Well, on the road between Abdal and Sa-tscheo. And we soon had ocular proof of the fact, that the *astin-jol*, or »lower road» — it was the *üstün-jol*, or »upper road», that Littledale followed — really did pass through that spot, for we saw the fresh track of a caravan of a dozen camels, probably carrying fish or silver from Abdal to Sa-tscheo.

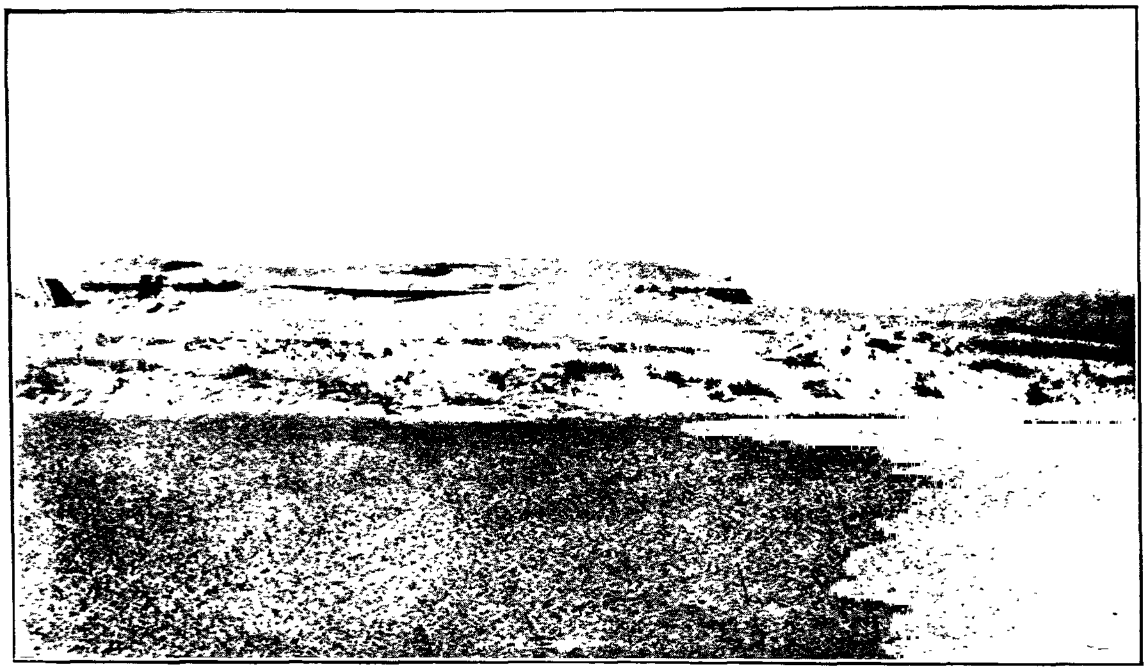


Fig. 223. A VIEW FROM THE SOUTHERN CLAY TERRACE PARTLY COVERED WITH SAND.

Here again we dug a well, the temperature of the ground being — 1.5° at 25 cm., + 0.4° at 50 cm., + 1.6° at 75 cm., and + 2.1° at 86 cm., where we struck the ground-water. The sp. gr. was 0.0215, so that the water was absolutely undrinkable. On the north-west slopes of a couple of dunes, immediately under the crest, there still remained a narrow ribbon of snow, so that there must be some downfall there, as well as in the Kuruk-tagh, during the winter. The grazing at Atschik-kuduk is rather poor, and as both water and fuel are wanting, caravans avoid the place, preferring to encamp at a spot about 10 km. farther to the east, where the grazing is said to be a good deal better. The caravan I have mentioned had marched straight on without stopping at Atschik-kuduk. There were also signs of another caravan, which had passed apparently about a month before. The footprints were quite distinct in the moist, marshy schor, showing up white against its dark brown surface by reason of the thin efflorescences of salt with which they were lined.

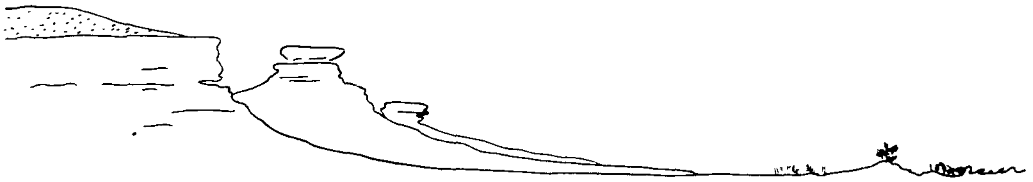


Fig. 224.

On the 6th February, after the little kamisch oasis of Atschik-kuduk had thinned out and melted away, the ground still preserved the same characteristics, and was so soft that the camels advanced very slowly and heavily, leaving deep foot-

Pl. 55.

Ljustr. A. B. Lagrelius & Westphal.

MASSES OF CLAY RESEMBLING RUINED TOWERS AND WALLS (SEE P. 493) BETWEEN CAMP CXXXVIII AND ATSCHIK-KUDUK

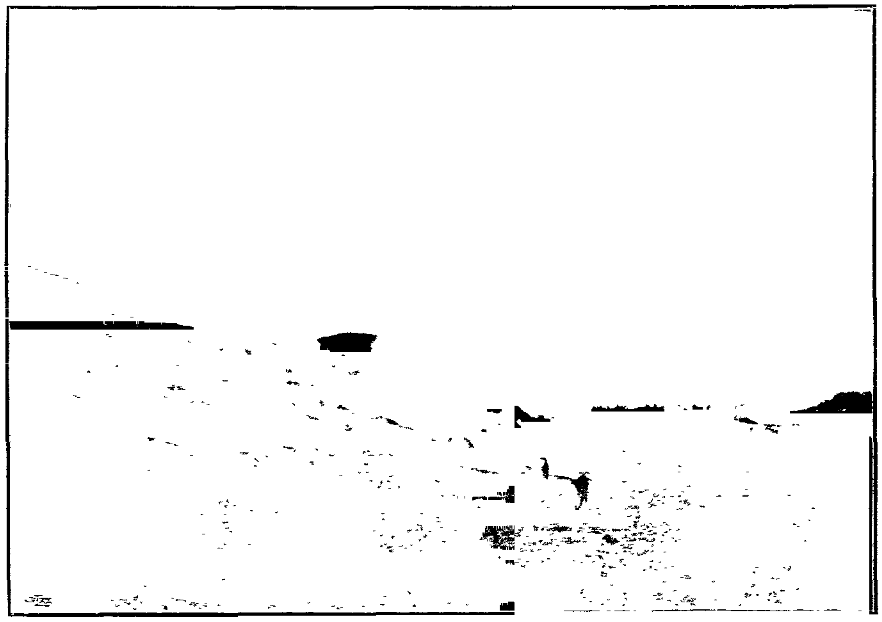


Fig. 225. ON THE ROAD TO TOGHRAK-KUDUK.

prints behind them. At intervals it was diversified by small hills with dead kamisch, while to the north were patches of still living vegetation and mounds crowned by still living tamarisks. To the south were several gigantic yellow clay terraces, and beyond them continuous drift-sand. Our route ran towards the west-south-west across schor, thinly dotted about with kamisch. Connected sand came quite close to us

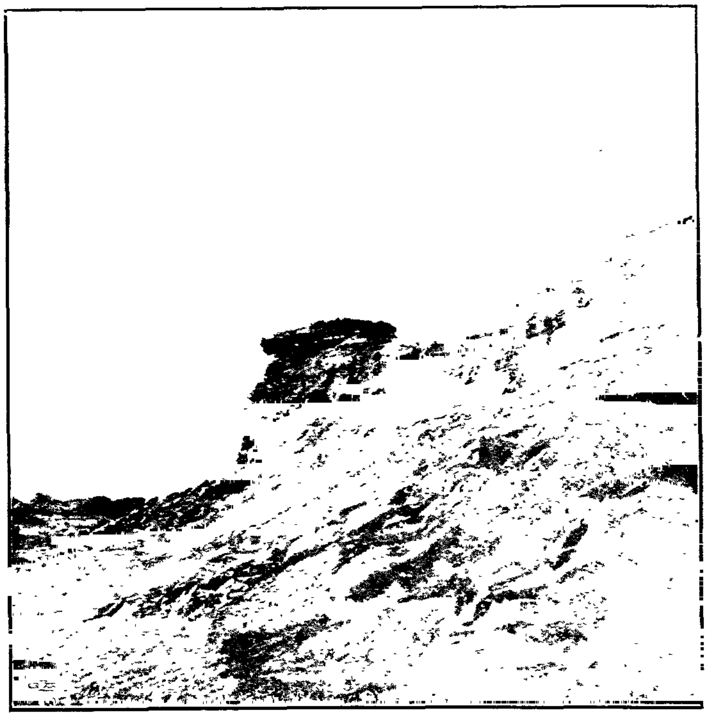


Fig. 226. PROJECTING PART OF THE TERRACE NOT FAR FROM TOGHRAK-KUDUK.

on the south, tamarisk-mounds being between it and us, while to the north was a level dark surface, diversified by lighter areas, clearly isolated patches of sand. Then we crossed a small offshoot of sand, the dunes of which turned their steep faces towards the west and west-south-west. To the west of that however the country underwent a total change. To the north of our route we had a yellow kamisch steppe, dotted over with solitary tamarisk-mounds and extending to an immense distance in every direction. To the south, immediately on the left of our route, ran a high, distinctly defined clay terrace, sometimes steep, sometimes with a gentle slope, and sometimes descending by steps of varying steepness. In some places smaller portions of it stood free and detached in front of the main terrace. The surface of this last was covered with low drift-sand, which continued towards the south, probably as far as the foot-hills of the Astin-tagh. Between the foot of this terrace and the kamisch steppe there was a band of rather hard, coarse sand, 10 to 50 m. broad, with two old wells which have fallen in. Farther on there is a distinct track across the kamisch steppe, well trampled by caravan animals.

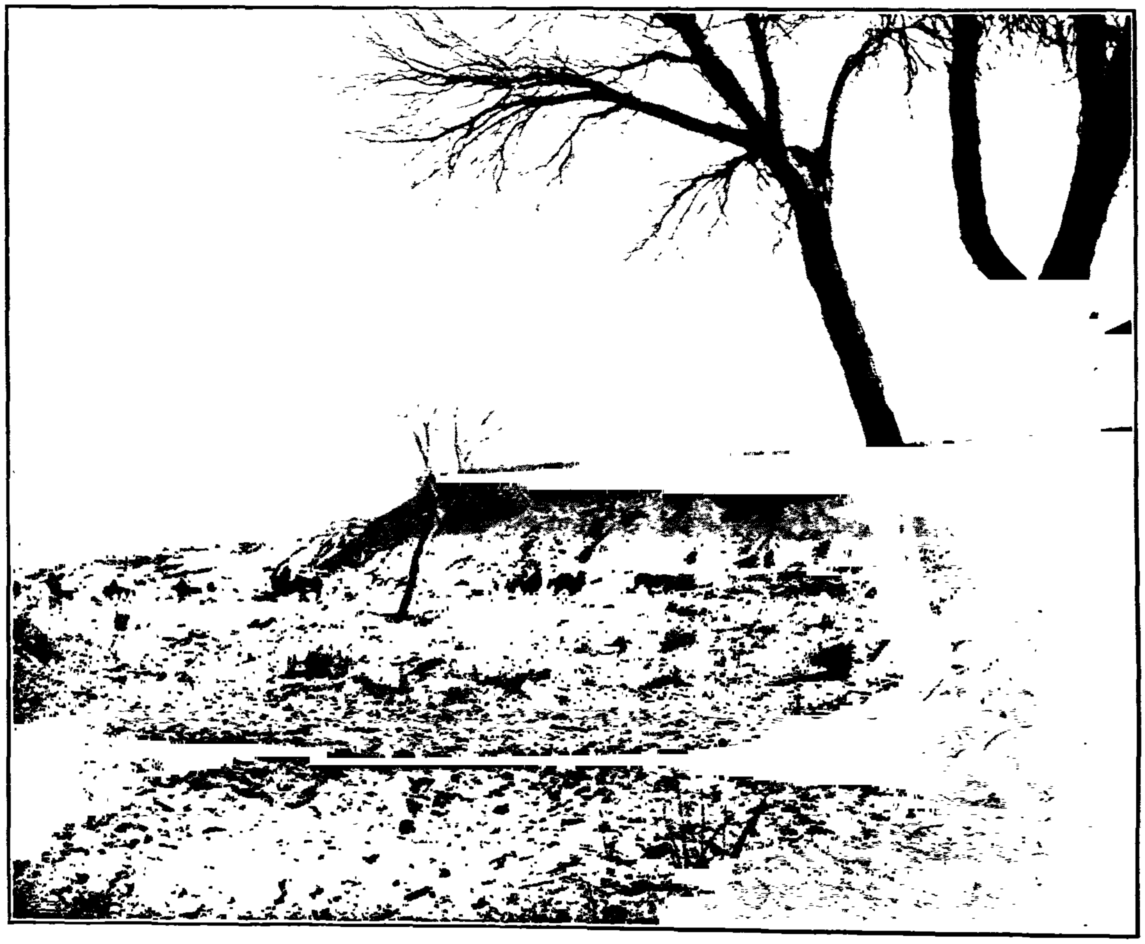


Fig. 227. THE TERRACE LOOKING EAST FROM TOGHRAK-KUDUK.

Toghrak-kuduk, or the Poplar Well, was 1.64 m. deep and its water was covered with ice 8 cm. thick, the water itself being 43 cm. deep. The sides of the well were supported by poles, to prevent them from falling in. The areometer recorded a sp. gr. of 1.0036, so that the water was relatively drinkable. In the immediate vicinity of the well were five perfectly vigorous poplars, of a mature age, and without any trace of mounds.

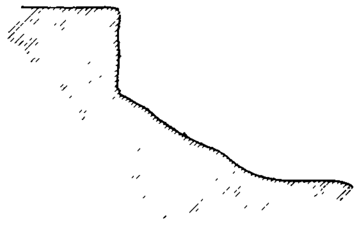


Fig. 228.

Close to our camp the front of the clay terrace was 26 m. high, the upper 14.6 m. of which made a perfectly vertical wall, and was continued below by a sloping scree. From the top, where there was a *nischan*, or "sign-post", namely a pole set up on end, sand was visible a few hundred yards away to the south-south-east and to the south-west. Westwards the kamisch steppe extended to the horizon.

On the 8th February we turned away from the *astin-jol* and marched north across hard, dry schor, with tolerably abundant kamisch, interspersed with occasional patches of bare ground. But the vegetation soon thinned out to a few scattered clumps growing on low flat elevations. In two places we passed eight small, quite young toghraks, together with tamarisks on mounds. After that the kamisch quite came to an end, and the surface grew lumpy, and was dotted over with saline efflorescences, sometimes forming patches of salt a couple of centimeters deep. And the ground continued to be barren until we reached a series of rounded mounds, with living *schap* scrub on their northern faces. Farther to the east, were other similar mounds, though without vegetation. Upon looking back from this point, we were scarcely able any longer to see the clay terrace; but on the other hand the drift-sand with which it is covered was all the more conspicuous, its yellow denticulated outlines showing up in sharp-cut relief and exhibiting distinctly their steep slopes facing the west. The sand is however on the whole rather flat, there being only two or three places in which it has piled itself up into accumulations of any size. Finally we reached a belt of vegetation, with an abundance of small, low mounds, all crowned by withered tamarisks and kamisch, though far more scattered than at Toghrak-kuduk. Here the tracks of wild-camels were extraordinarily numerous. The boundary of this, the last belt of steppe before we reached the Kuruk-tagh, was exceedingly sharply defined. From its edge the hard gravelly saj slopes slowly up towards the first offshoots of the terraced clay hills, which have been already described in a previous chapter. The terrace appeared to die away and disappear in the N. 72° E., though in the S. 71° W. it sends out a cape or finger, and in S. 49° W. we could again faintly distinguish other projecting portions of the same terrace.

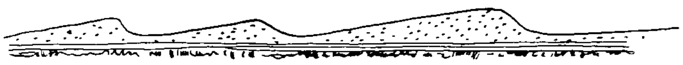


Fig. 229.

We dug a well, going down through nothing but sand and gravel. The temperatures here were appreciably higher than at Toghrak-kuduk, but then this latter is more screened by its clay terrace. At 25 cm. down the thermometer registered

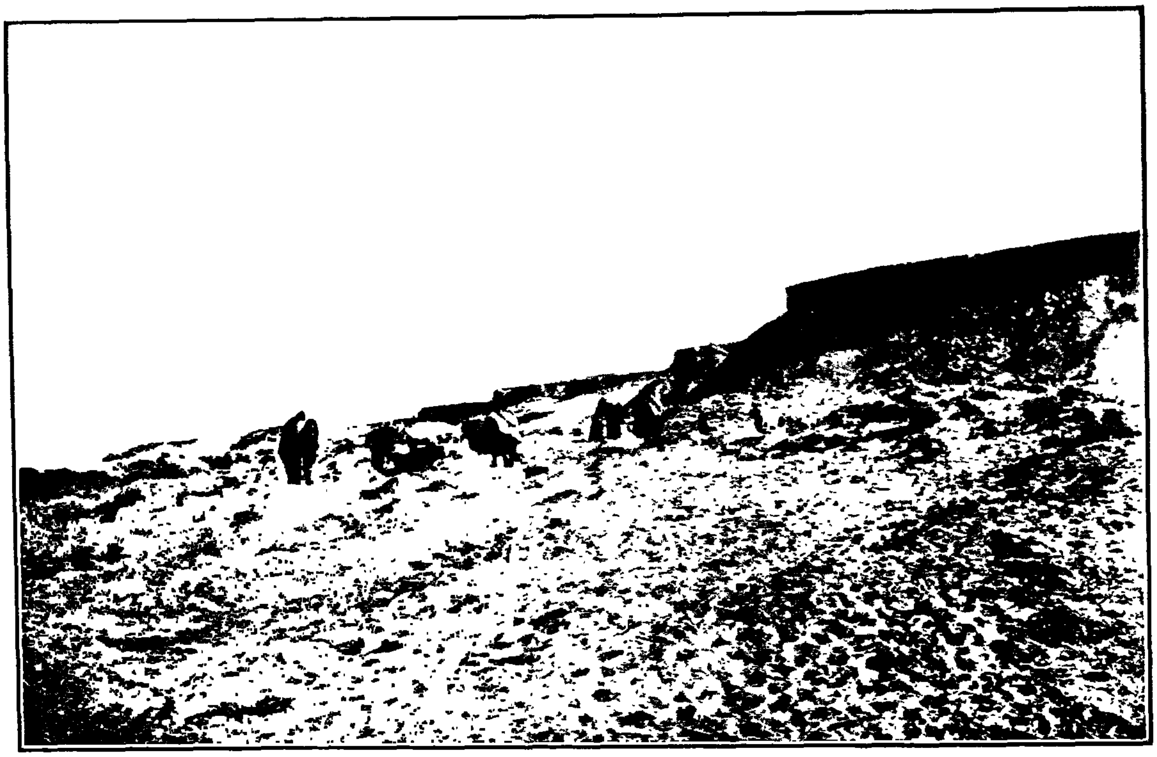


Fig. 230. ANOTHER VIEW OF THE CLAY TERRACE.

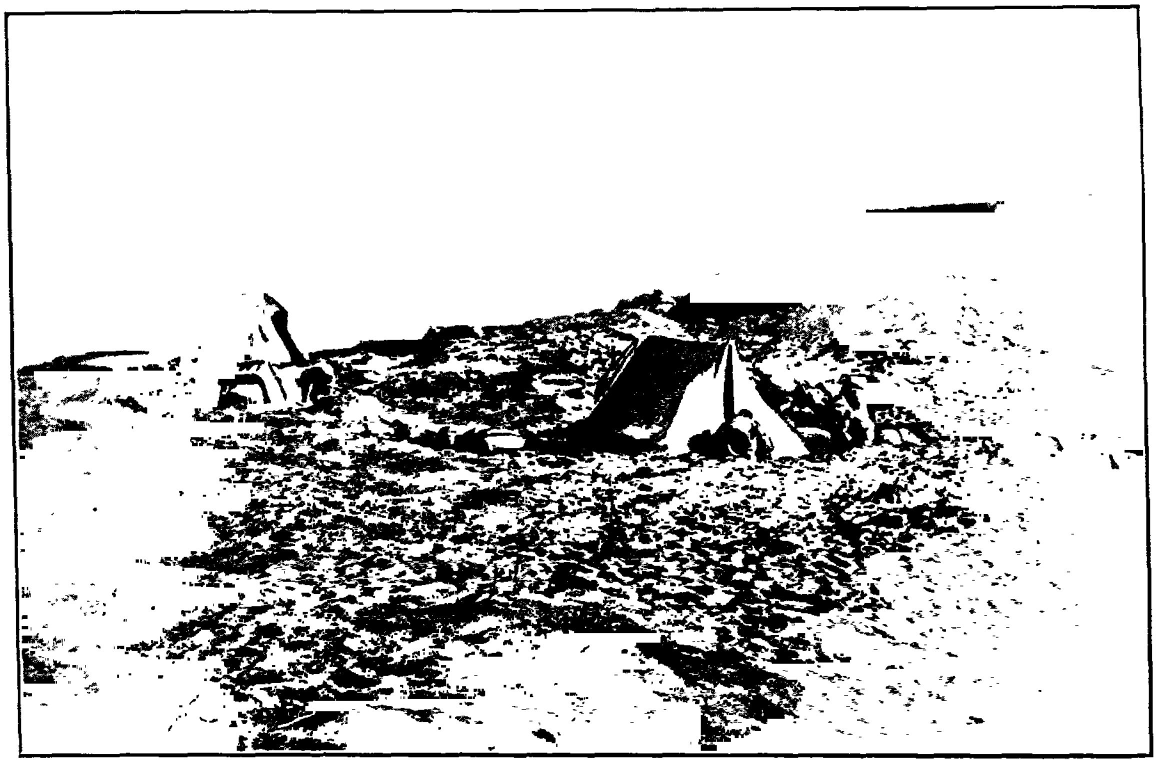


Fig. 231. MY CAMP AT TOGHRAK-KUDUK.

+ 2.3°, at 50 cm. + 3.4°, at 75 cm. + 4.6°, and at 1.20 m. + 6.5°. The water, which we struck at the depth last indicated, was a good deal salter than at Toghrak-kuduk, for the areometer gave a reading of 1.0082.

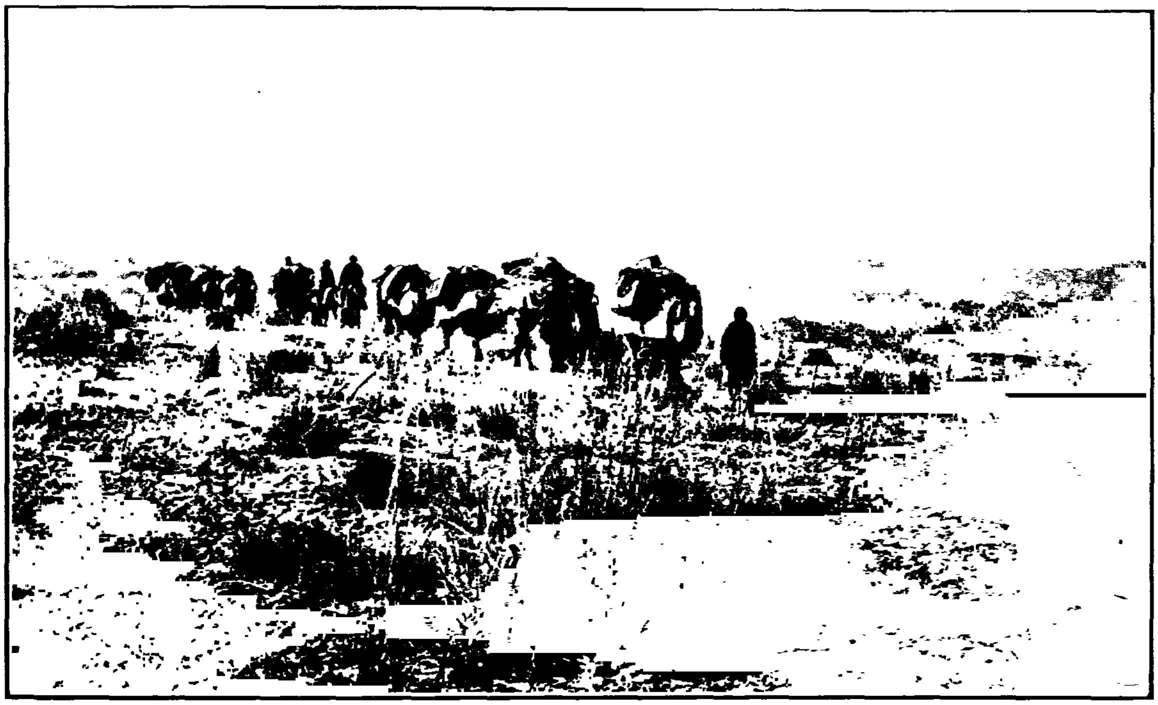


Fig. 232. THE LAST BELT OF VEGETATION ON THE ROAD TO KURUK-TAGH (see also Pl. 6 and 7).

Thus we had crossed the Desert of Gobi. In the region where our journey was taken we found it to consist of a series of successive belts, running for the most part from east to west. The first belt, which began at the mouth of the Anambaruin-gol, extended as far as the small desert-ranges, and consisted of steppe vegetation of a pretty dense character. All the watercourses of that tract were concentrated into one main watercourse, which was forced by the desert mountains to bend to the west. North of these mountains was a narrow belt of drift-sand, heaped up to a very considerable height, against which the small desert-ranges acted as a sort of breakwater, preventing it from overwhelming the belt of steppe to the south, and on which there was not the smallest beginning of dune-formation. But the more energetically, and the more violently therefore, has the drift-sand piled itself up against their northern foot, penetrating into those that are sufficiently open, as well as climbing a long way up the mountain-side. This arrangement of the sand agrees perfectly with the law laid down by Potanin, that in the basins of Central Asia the sand is heaped up in greater mass on the south, all along the bordering mountain-ranges, where the floor of the depressions lies at the highest level.

The first zone of drift-sand is succeeded by a region which exhibits proofs of wind-modelling on an extraordinarily energetic and well-developed scale, the results corresponding to the jardangs and the wind-eroded gullies of the Desert of Lop.

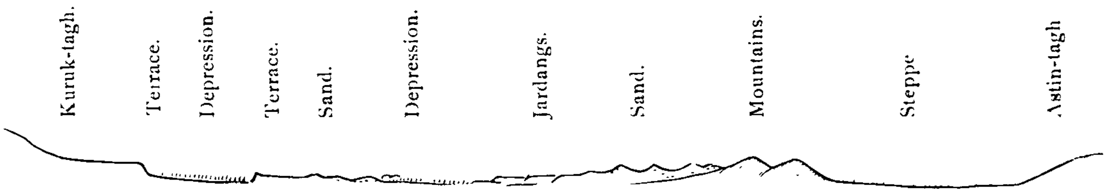


Fig. 233.

Both sets of phenomena lie parallel to one another; from this we may infer that the winds which prevail in the two deserts are the same. Next comes, sharply demarcated from the zone just described, a more or less thin kamisch steppe, growing on level ground; and this in turn is followed by another very narrow belt of sand, immediately south of Atschik-kuduk. After only a single crossing it is however impossible to determine in what way this belt of sand is connected with the more considerable belt to the south. It is however almost certain that both belong to the same expanse of drift-sand, and consequently are in unbroken connection one with the other to the west of the route we followed across the kamisch steppe. At all events the sandy desert (Kum-tagh) to the west of our route is broader and more developed than it is to the east of the same.

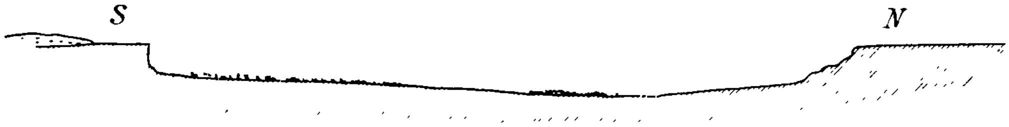


Fig. 234.

Finally, in the extreme north we have the characteristic and sharply defined belt of kamisch steppe, stretching from east-north-east to west-south-west, and bounded on north and south by high sharp-cut clay terraces. How far these extend east and west it is difficult to say. Probably they attain their greatest development in the part of the desert where I crossed them, and there too the flat gulley, a deep elongated depression, is at its narrowest. At the points where we measured them, the northern terrace was 34.5 m. high and the southern 26 m. But if to this we add the elevation of the up-sloping gravelly scree, the base of the former terrace is relatively a good deal higher than the bottom of the depression at Camp No. CXLI. And probably a similar addition ought to be made to the southern terrace, though to what extent was not apparent owing to the gentle fall of the steppe towards the north. Both terraces belong to the same level, and would appear to correspond to the shore-lines of a big bay of the last surviving remnant of the Central Asian Mediterranean. At the point where I crossed it, the depression was 10 to 11 km. wide, and thus resembled a flat valley or immense river-bed (see fig. 234, where the vertical scale is of course exaggerated).

# GENERAL HYDROGRAPHY OF THE TARIM SYSTEM

*Ljustr A B Lagrelius & Westphal*

CAMP CXXXVIII. CAMELS DRINKING AT RECENTLY DUG WELL (SEE P. 491).

# CHAPTER XXXV.

## TSCHERNOFF'S EXPEDITION.

Before I proceed to a general résumé of the entire Tarim system I will adduce the results of an excursion which was made in the winter of 1900—1901 by my Cossack Tschernoff up the lower Tarim from Tscharklik. As I have myself already visited the district in question, it may perhaps appear superfluous to return to it again. A great many of the names which appear in vol. I occur again in Tschernoff's itinerary, but he records also a great many new ones, and it really is for the sake of recording them that I have deemed it expedient to dwell for a moment upon the results of his journey, and all the more so as he visited several tracts which during my own journey I had no opportunity of visiting. Tschernoff mapped the whole of his itinerary, embodying the results in 28 sheets; but the work is so rough and primitive that I have been unable to use them as a continuation of my own cartographical results. Nevertheless for the sake of curiosity I append a couple of them here. Tschernoff himself was unable to write, and the text which accompanies the maps was written at his dictation by my Mahomedan secretary, Rosi Mollah. Generally speaking the narrative contains little that is new or interesting; but such of it as falls within either of these categories is quoted in the following extracts.

The little company started from Tscharklik on the 3rd January, and returned to the same place on the 7th February. On the way out they rested three days in Tikenlik, and one day at Jangi-köl, while on the return journey their only rest was one of two days at Tikenlik. Thus the number of actual marching days was thirty. As certain of the stages of the return journey coincided with stages made on the way out, no observations were recorded for them.

The following are the names noted for the first day out — Tscharklik, Konaschahr (ruins north of Tscharklik which I visited in 1896), Hejtmet Mirabninglengeri (a station-house), Kesken-toghrak, Multuk-kojghan (in a belt of tamariskmounds), Kuduk-kaulaghan (in a schor region), Dung-otak (likewise a region with tamarisk-mounds), Nadschi-bidschin, near which an old *potaj* was seen. Thus far I also covered the same route in 1896 when I travelled from Abdal to Tscharklik. Beyond Nadschi-bidschin they quitted that route, leaving it on the right hand, and went to Lop. On the way they crossed the Julghunluk-terem, a little river-arm traversing saline soil, where also tamarisks grow, and the Kok-ala, another river-arm there divided into two branches. On the 26th April 1896 I found that the Tscharklik-su reached a little way below Nadschi-bidschin, and there overflowed its bounds at no great distance from the Kara-buran. According to Tschernoff's map the arms just mentioned proceed from the Tscharklik-su, and the Kok-ala, even though it was the beginning of January, still contained a little water. The »sign-post» of Kurban Bekning-ilesi is situated in a completely *schor* desert. And such the surface continues all the way to the shore of the Kara-buran. The sheets of water that still remained in this marsh were frozen over, and at the point where the expedition crossed it, it was more than two kilometers broad. Patches of yellow kamisch still projected through the ice. They were told however that that region had not been under water during the summer, and they themselves reported that, at any rate along the line of their route, the lake appeared to be greatest in winter. The truth is said to be, that in winter the water of the Tscharklik spreads itself over a considerable area in the form of sheets of ice, so big as to convey the impression of being lakes. After that they crossed the Tschertschen-darja on the ice and a quarter of an hour later reached Lopning-örtäng, a Chinese station-house at the fishing-village of Lop, in a district where tamarisk-mounds are plentiful.

The next day they went as far as Jakub Bek's fort, traversing a region that still belongs to the area inundated by the Tschertschen-darja, a fact to which several of the names allude. First came Kurban Bekning-teremi, or the River-arm of Kurban Bek, where they saw large sheets of ice or frozen lakes on both east and west. On the western shore of the lake of Kum-köl they rode through a belt of tamarisk-mounds, and then crossed the plain of Ullugh-tschöl, where steppe vegetation was growing. The next name is Nam-köl, where the ground was moist and kamisch was growing; but they saw no lake there, whereas Kum-köl on the other hand appeared to be a permanent lake. Their Kurghan is clearly identical with the place known to Prschevalskij and myself as Jakub Bek's fort.

From the third day's itinerary a few names are readily recognisable. Two small canals which issue through the right bank of the Tarim and water some grazing-grounds to the west of the river bear the names of Kurban Supaning-birintschi-tschapghani and Kurban Supaning-ikintschi-tschapghani. Other names are Jangi-köl, or the New Lake, though it then contained no water; Jäkän-boldschemal; Turna-toghdi-tscheke; and finally Tokum. At the three last-named points, as well as at Kurghan, their route touched westward-going loops of the river.

The names belonging to the forth day are Tal-kirtschin-tscheke; Almontschuk, where they noticed two small marginal lakes, one on each side of the river; Argham-tschi-baghlaghan-tscheke; Jaghlik-tschökken-tscheke, and lastly Arghan. Thus from Tscharklik to Arghan they followed the *örtäng-jol* or »great caravan-road», running along the right bank of the Tarim, no doubt because the surface on that side is free from sand, this having been swept away by the storms, whereas the eastern bank is encroached upon to a greater extent by the sand as well as pierced in several places by the deltaic arms of the river.

On the fifth day they followed the great caravan-road towards the north-west, touching the western loops of the Jätim-tarim. The points at which they touched were Masarem; Sar-tokkan, a district in which there are toghraks, tamarisks, kamisch, and steppe plants; Ak-jaghatsch, with an old hut; Jügen-taravaldi-tscheke, this, like the preceding, a loop of the Jätim-tarim, with toghrak forest; and so too are Ottuk-tscheke and Karaune-tschekesi, where the kamisch is not only plentiful, but also dense and magnificently grown; Tarischi-sindi-köl; and Kara-daj-örtäng, with a station on the great caravan-road.

Sixth day — Dscham-kojghan-tscheke; Telep-köli; Dilgerning-uji; Abdal-tschapghan; Sitmet-kojghan-kemi, where they crossed the Laschin-darja; Karaune-tokkan-köl, a lake now dried up; Patma-ölgen-uj; Sadik-on-köngen-dung; Attamet-köligi, with a couple of small lakes; Tarbus-jeghan-dung; Dural; Avulning-köli — at most of these places there was toghrak forest, even though it were only in scattered clumps; finally Tikenlik.

Seventh day — Jalghus-toghrak, where, as the name indicates, there exists a solitary poplar, accompanied by the usual vegetation; Kasi-kalaning-kona-köligi and Abdul Bakining-kona-köligi, two old dried up lakes still bearing the names of their former owners; Säfär-kasdi; Moessining-uji; Katik-arik-tschekesi; Ara-kum, »the Middle Sand», one of the few belts of sand that still remain between the deltaic arms of the Tarim; Kong-köluk, where they crossed the bed of a former lake; Tam-uj, a clay hut; Kurban-kulluning-terem-baschi; Gen-deng, a Chinese station-house, where the expedition crossed one of the kok-alas of the Tarim; Töllögöning-uktusi, with a small lake; Kuslek-mähälläsi, or the village of Kuslek already named.

Eighth day — Kara-dung, the place already mentioned; Ak-tarma, the village known from Prschevalskij's time; Taschlap-kätgen-uj; Kesgen-tarim, where a river-arm was crossed; Gen-deng; Bos-köldake-kona-uj; Ullugh-kölning-ak-tarmasi.

Ninth day — Tungani-tüschdi-tscheke, a loop of the Tarim; Masar; Taraschakotan; Haser-ölgen-uj; Chodscham Käldining-tongusluk-uji; Muti Achun-ulturghan-ak-tarma-uj, a deserted village near Jangi-köl.

From that point the expedition turned back and travelled ten days towards Tscharklik, keeping at first along the northern bank of the Tarim and passing Kara-tschatsch, Kudschek, Karaunelik-köl, and so reached Ullugh-kölning-aghsi, or the mouth of the canal of the Ullugh-köl where it enters the Tarim. Thence they proceeded to the upper, northern basin of the Bajir-köl, and from that point crossed the ice southwards on foot. Although the text speaks of Birintschi-, Ikintschi- and Ütschintschi-bajir-köl, Tschernoff has distinctly marked four basins on his map, separated from one another by *boltas*, or »sounds», where capes jut out from both sides. The widest of these boltas is the one farthest south, and it has a little island in the middle. The Bajir-köl is said to be continued south-westwards by a dry bajir, with an abundance of kamisch. Another bajir in the vicinity is said to contain water. Along the shores of the lake were tamarisks, kamisch, and an occasional poplar. Unfortunately the map is so unreliable in its compass-bearings that it cannot be used even to complete Pl. 12 of my atlas. According to Tschernoff's itinerary, the lake should be 6 or 7 km. long; but his statement that it is shaped like a bow, convex to the east, strikes me as being improbable, and I have therefore preferred to adhere to the oblong form in Pl. 12, giving it only a slight curve towards the east. According to the oral information I received in the locality of Ullugh-köl, the lake consists also of four basins.

The itinerary indicates as the camping-ground of the tenth day Muhamed Supaning-satma-uji, a place which does not appear on my map, for the simple reason that I was not told of its existence. Yet names such as this possess no geographical value; it merely indicates a hut or homestead, which perhaps has only quite recently been built.

The observations that Tschernoff made on the eleventh and immediately following days are of especial interest, because he then touched regions which I have not visited, so that his information will serve to control that which I received from hearsay. From the camp last-mentioned he proceeded to the mouth of the Kum-köl canal and then rode across the lake to its southern shore; and as this took him 55 minutes, I estimate that the lake is 4 to 5 km. in length, thus being a good deal longer than I was told it is. Consequently the lake, which appears in dotted outline on Pl. 12, is there too short. On the other hand the shape which Tschernoff assigns to it is improbable. One fact stands forth however with indubitable certainty on his drawing, and that is that the lake is divided into two basins. The western cape at the bolta is very sharply defined; and no similar cape is shown on the right side. The lake is indicated as being surrounded on all sides by the usual dune-accumulations, while poplars and tamarisks grow on its shores.

After returning to the inflow canal of the Kum-köl, Tschernoff travelled along the southern shore of the Jalang-dschajir, which lies, as I also was told, entirely north of the great sand. On its shores too, even on its southern shore, notwithstanding the close proximity of the sand, poplars and kamisch grow.

Riding south from the eastern end of the Jalang-dschajir, across the dune-accumulation, they discovered the lake of Putej-bajir-köl, of the existence of which I never even heard speak; perhaps it was not known to my guide. The name is reputed to mean the Bajir Lake without Inflow, though the lake is believed to be fed by an underground supply. According to Tschernoff's map and brief text, it would appear that this is one of the ordinary characteristically elliptical or round depressions which are everywhere surrounded by sand, somtimes even on the north, where the usual inflow canal is stated to be absent, as well as on the south, where a sandy threshold separates the Putej-bajir-köl from a big dry bajir which forms its continuation in that direction. This newly discovered lake appears to belong to the same type as the Toghraklik-kölning-daschi and the Ilias-bajiri, but its water is so far fresh — at all events it is so in its northern basin — that it was frozen over, a circumstance which does seem to support the view that the lake has an underground connection with the Tarim. According to Tschernoff's map of this region, which I herewith reproduce in facsimile (fig. 235), the Putej-bajir-köl contained three sheets of water. Between this lake and Torpak-öldi he has inserted between two accumulations of sand yet another elongated depression, consisting of five separate basins, of which only the northern one, an unnamed lake, contains water, and which the travellers only saw from a distance. My sketch-map on Pl. 48 of vol. I shows only one elongated depression between the Kum-köl and Torpak-öldi, but it now appears that there are two.

After returning across the sand to Jalang-dschajir, they had a three-quarters of an hour's ride to the Torpak-öldi. This lake they also rode down from end to end: it took them 65 minutes, so that the lake is 5 to 6 km. long, and consequently a little bigger than it is shown on Pl. 12. Then they went to Bajir-köl No. 2, and found that it is continued by two dry bajirs. By following the river-bank they reached Lakuluk-tarim, and rested at Dschan Niasning-satmasi, evidently a deserted village, which was stated to be situated on the *bajirning-aghsi* or the entrance to the Bajir-köl.

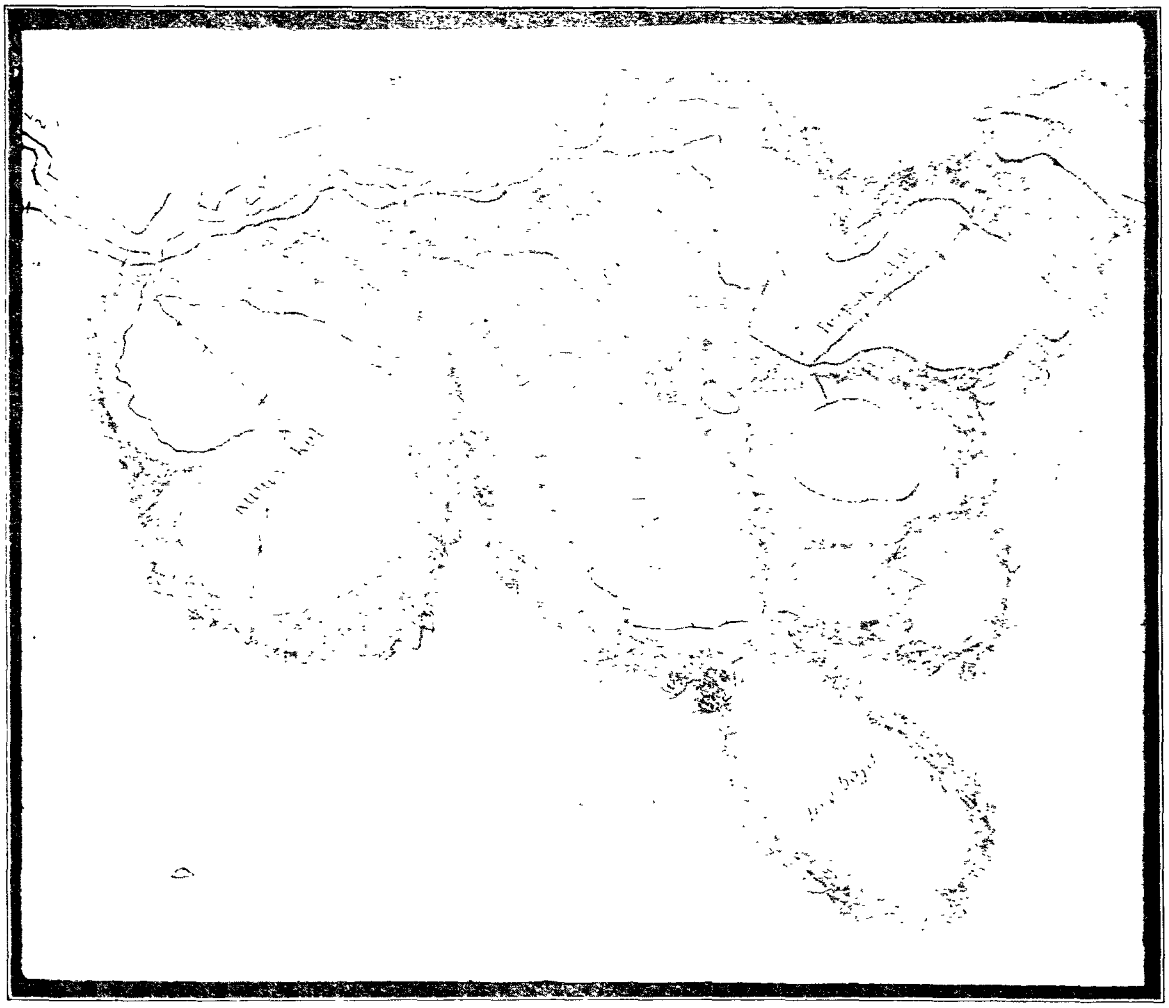


Fig 235. KUM-KOL AND TORPAK-OLDI AS DRAWN BY MY COSSAK TSCHERNOFF.

The twelfth day was devoted to this lake. The only information I myself gleaned concerning it has been already communicated at p. 287 of vol. I. It is said to consist of four separate basins, of which the three upper ones bear the names of Lakuluk-köl, Dschan Nias-köl, and Muhamed Aru-köl. The first two of these names reappear on Tschernoff's map, although they indicate a *tarim* and a *satma* respectively. His description however makes it plain that the lake is complicated. He says that from the aghsi of the Bajir-köl it was a 25 minutes' ride to Islam Niasning-köli, and from there a ride of 50 minutes to Niser Kulluning-boltasi and Ahmetning-boltasi, which are said to form a separate, though now dry, lake-basin. Thence it was only 5 minutes to the Mahametning-köli, but to ride across this lake took 25 minutes. After that they crossed over an accumulation of sand to Ejsaning-kakmasi, which is apparently only a southerly bay of the next lake, the Dschan Nias-köl. This is 5 to 6 km. long, and in respect of its shape it so far resembles the Ullugh-köl that at its south end it has two bays, one of them being that which I have just named. And Tschernoff's sketch-map shows plainly, that it must indeed be so. Kamisch is quite plentiful beside these lakes, and toghraks and tamarisks also

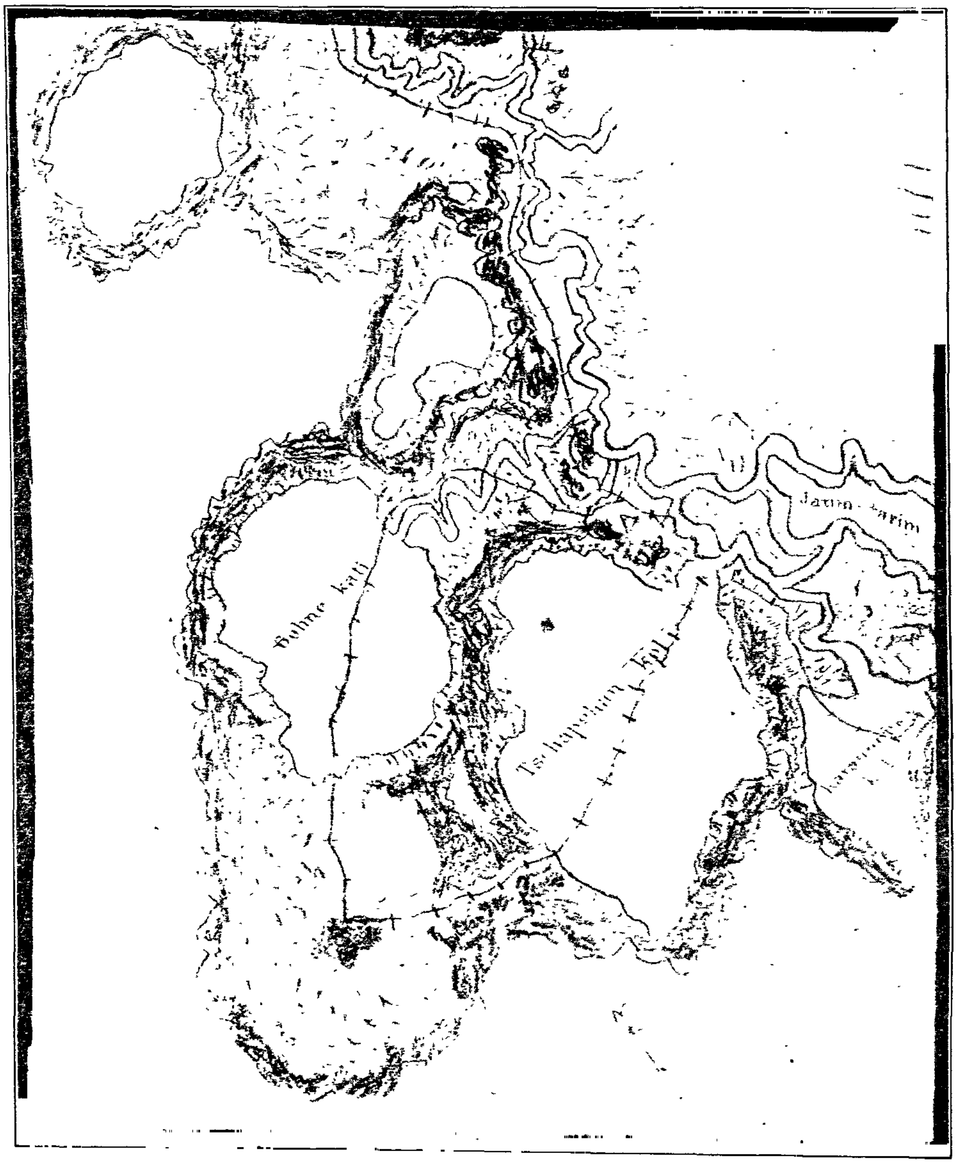


Fig. 236. FACSIMILE OF ANOTHER SHEET MADE BY TSCHERNOFF.

occur. Then, turning, they rode back to Islam Niasning-köli and the Mahametning-köl, the *kok-ala* or canal of which leads eastward to the Jätim-tarim, a minor arm of the Tschong-tarim flowing through the sand. Beside this they rode as far as the Ötäk-kaldi arm of the Tarim. Another arm in that same neighbourhood is known as the Kose Kirgen-kok-ala. From the top of the high sand to the south they perceived, farther on in the same direction, a large dry barren bajir, wedged in between the Bajir-köl and the Gölme-käti No. 2. Thence they travelled to the inflow canal of this latter lake, and so on to Kasi-kallaning-tschapghandaki-kona-satmasi, where they encamped. Down to that point the arm of the Tarim which they had followed was called the Jätim-tarim. To judge from Tschernoff's description, the Tarim at that spot would appear in the beginning of 1901 to have been very greatly subdivided and very uncertain in its course. Young poplars, tamarisks, and kamisch were growing on its banks.

On the thirteenth day they visited the Gölme-käti, approaching it by its canal, which is long. To ride from one end of the lake to the other took them 36 minutes; there were poplars on its banks. Immediately south of the lake they rode across a large bajir, which, according to Tschernoff's description, would appear to be of a very unusual character. Poplars abounded within its arena, and there was an isolated sand-hill in the middle of it, the top of which commanded an extensive view (fig. 236). Then they climbed over the accumulation of sand which separates that bajir from the Tschapghan-köl. This lake they likewise crossed from end to end, the ride taking 46 minutes. Here again there were poplars. After that they followed the Jätim-tarim as far as the Karaunelik-köl, the same lake as my Karaunelik-tokkan-köl. Both this and the next following lake, the Jilgha-köl (absent from my list), were crossed on the ice. Finally, crossing the Kurban Pavaning-tägirmän, they reached the canal mouth of the Laj-baskan-köl, where they encamped.

The narrative of the fourteenth and immediately following days shows, that below the Karaune-tokkan-köl there must be a number of small lakes not enumerated on my list. Several of them are quite small; others form parts of the lakes about which I was told. Tschernoff however enumerates them in a different order from what I have done. His map proves clearly that the marginal lakes on the right bank of the Tarim are just as numerous below the region I examined, namely down to and including the Ullugh-köl, as in the region above this lake, i. e. up as far as the Teis-köl. It is difficult to obtain a perfectly clear conception of the wonderful hydrographical arrangement in that region; Tschernoff's map is not *per se* sufficient to enable us to arrive at quite trustworthy conclusions. This much may however with tolerable certainty be inferred, namely that these lower marginal lakes are doomed to dry up, now that the Tarim has deserted its old bed in favour of more easterly arms. An accurate mapping of this country also would no doubt have been of interest, though, as I have already observed, there was the less necessity for it, seeing that the region of these marginal lakes is everywhere of a stereotyped character, and that the lakes which figure on Pl. 12 are quite sufficient to give a conception representative of the general geography of the region as a whole. We have however one beautiful example of these lower marginal lakes in the Begelik-köl.

A quarter of an hour's ride brought the travellers from the *aghsi* of the Laj-baskan-köl to the lake itself, after which they traversed this last on the ice right away to its opposite extremity. On its shores were young poplars dotted about here and there. Towards its northern end there is a large sandy island, which appears to be of the same type as that in the Ullugh-köl. Farther south a narrow *bolta* cuts off a *kakmar* or southern basin from the northern, and in that too there is a small island. The canal which feeds the Laj-baskan from the Tarim seems also to send off an arm to the Talaschti-köl, a lake situated farther to the east. In this branch there is an expansion known as the Dughulge-kök-köl: and from it the travellers reached the Talaschti-köl-aghsi. The lake of this name is divided into three basins by projecting promontories which form boltas. The northern basin, the Aghis-köl, is said to lie 20 minutes' ride from the Jätim-tarim. In that locality this last name appears to be applied to the older bed of the Tschong-tarim, now for the most part abandoned. The connection between the river and the Aghis-köl seems to be of the same type as that between the Tarim and the Daschi-köl, that is to say a broad passage filled with sandy islands, the latter overgrown with vegetation. Immediately to the east Tschernoff perceived the Murabning-köl-kakmasi, probably nothing more than a part of some adjacent lake. The name given to the middle, and at the same time the largest, basin of the Talaschti-köl is Ghol-köl: while the smallest basin of the three, lying farthest south, possesses no name. One piece of information given both by the text and by the map is certainly strange, namely that all over the Ghol-köl there are small islands and islets of sand, tamarisk-mounds, and clumps of kamisch, as well as here and there a solitary poplar, sticking up through the ice. I confess I never saw anything like that in any of the lakes higher up. From this we may infer that the Ghol-köl is exceedingly shallow.

Climbing over the dune-accumulation, that overhangs the eastern shore of the Ghol-köl, by a gap or saddle 3 to 4 km. across, they came to the little lake o Baschtage-köl. This lake is connected by a canal called Tömen-akin with another Aghis-köl, a lake so small that it only took them a quarter of an hour to ride across it. That brought them to a place known as Arelisch, where there is a bifurcation: there they spent the night.

On the fifteenth day they rode beside the river down to the Kemi-tschapghan-köl. The northern bank was clothed with poplar forest, but the high sand began immediately south of the river. The following names were noted — Koj-salghan-togh, Kara-tschilandake-togh, Usun-kara-tschilan, Ajagh-kötörmadake-koschlusch, and Jäkän-okluk on the Jätim-tarim; further Chodscha Kulluning-uj, the feeding canal of the Baschtage-köl, and the aghsi of the Ottak-köl. Camp was formed at Ojman-köldake-uj.

On the sixteenth day a circular tour was made from the camp just mentioned, a group of lakes being visited on the way. First they went to Jätim-tschapghan and the Tschapghan-köl, which they crossed on the ice in 18 minutes. Here only a very narrow tongue of sand separated them from the Tschong-tschapghan-kölning-aghsi. The lake of Tschong-tschapghan-köl, which they only just touched, appeared to possess its own connecting-channel with the river. A ride of a quarter of an hour across an isthmus of sand then brought them to the Begelik-köl, west of the lake last-named; but they merely skirted it, and then followed a canal or narrow sound, which conducted them to the Dungluk-köl, whence another narrow sound brought them to the Ku-tutghan-köl (Ku-tutu-köl), which demanded 53 minutes to ride across it. From the description which the expedition gives of the north-western portion of the Begelik-köl, it would appear to be even more complicated than I supposed it to be; but then I was not able to examine it, and for that reason it is shown in part with a dotted outline on Pl. 46 of vol. I. Towards the east it would also seem to send out fjord-like offshoots of the same character as the Avul Nias Bekne-kakmasi on its western side. Nevertheless I have not dared to incorporate the results of the expedition's labours on my map. A climb of 20 minutes from the eastern shore of the Ku-tutu over a dune-accumulation brought them to the lake of Ojman-köl, a lake entirely surrounded by sand and possessing but one or two solitary toghraks. This is not to be confounded with the other Ojman-köl through which the Tarim flows, although both lakes lie rather near together. The former is about 4 to 5 km. long, and is prolonged towards the south by a bajir. The expedition, leaving the northern end by its inflow canal, reached after a ride of 35 minutes the little lake of Putarlik-köl, situated in the immediate vicinity of Ojman-köldake-uj.

The next day, the seventeenth, they began by riding for an hour, until they reached the canal which carries water from the river into the Kök-köl. Another ride of 35 minutes on the ice carried them across this lake, which is divided into two basins by a bolta. South of it they discovered two small unnamed lakes. Then after 25 minutes over a sandy isthmus they reached what they describe as a *toghraklik-jer*, apparently a depression or hollow in the sand, where poplars grow abundantly. This little desert forest was 20 minutes in diameter. The next object visited was a small nameless lake farther to the east. Then across another low sandy isthmus northwards to a second Ghol-köl, which it took them 25 minutes to ride across, and on the northern shore of which stood a satma. North of the Ghol-köl was an accumulation of sand, and the country north of that again was called Toghraklik-eger-asti. Thence it was 1 1/2 hours to the dried-up lake of Schah Mansurning-ötäk-kölning-aghsi. Close beside it was Arsumet-kona-satmasi. A district lying between the river and the high sand was called Schikak; my Schikak-köl will evidently lie south of that district. The other names for that day are Jangi-suning-köl-aghsi, and, finally, the camping station of Jangi-su-mähällä.

The eighteenth day was utilised for an excursion to the adjacent lake of Jangi-su, which according to Tschernoffs' account is a desert lake belonging to the same category as the Begelik-köl and the other lakes. It appears to have an irregular and ragged shore-line, broken by numerous projecting capes and by boltas. A large basin on its western side bore no name. On its south-western and southern side were two bajirs with vegetation. South and east of the lake there are said to be *jilghas*, or »long, narrow valleys» in the sand, containing toghrak forest.

The following are the names recorded on the nineteenth day. First Ak-kattik-köl, an extremely small lake. Then Kala-sugha-jaghilghan-jer, a district beside the Kona-tarim, or an older bed of the Tarim long since abandoned, and lying south-west of the existing bed; this Kona-tarim is said to form an open strip or *jilgha* in the toghrak forest, and is very distinct. Next they made their way across a belt of sand to the Talaj-jatghan-tarim and Schukurning-kölning-koschluschi, evidently the ends of the canals from this lake, which is situated on the left bank of the Tarim. The same thing applies to the Kodajlik-köl. Finally they followed the Talaj-jatghan-tarim until they reached the camping-ground of Bisch-toghrak.

On the twentieth day a ride of 65 minutes brought them to the Kotschkatschi-köl, which according to Tschernoff's map ought to be regarded as a lake-like expansion of the river-arm just named, rather than as a marginal lake embedded in the sand, although it is possible that there may also be a lake of the same name in the sand to the south. After riding for another 65 minutes they came to the Chodscha-tutghan-köl which may possibly be identical with my Ghodsche-tutghutsch-köl, though this again is delineated as being a lake-like expansion. All the way the travellers had on the south the high barren sand. Beside the river were the ordinary vegetation and toghrak forest, but the age and density of this last are not stated. The next place they came to was Tschong-tarimning-koschluschi, that is the point where the Talaj-jatghan-tarim unites with the main stream. The Java Muhamed-basch-köl is the next name that occurs; this is a true desert-lake. They followed its western and southern shores for $1\frac{3}{4}$ hours. South of it there is said to be a dry bajir with toghrak and kamisch growing in it. Then crossing over an isthmus of sand, they came to another Tschapghan-köl, likewise embedded in sand.

On the twenty-first day the travellers passed over the upper Ettek-tarim and a belt of sand, and so came to the Kona-kuruk-ettek-köl, a now desiccated lake overgrown with vegetation, but formerly fed from the Ettek-tarim. After that they passed the well-known hill at Almontschuk, and encamped at Kultschakning-uji beside a small lake, probably a boldschemal.

The twenty-second day was devoted to an excursion towards the east, to the Karaune-tokkanlik-köl, a lake abounding in kamisch and jäkän, and with a large island in the middle, crowded with tamarisk-mounds, and here and there toghrak groves; a stream enters the lake at the north and issues from it again at the south. This is the lake mentioned on p. 208 of vol. I under the name of the Karaune-tokkan-köl. From that point they returned to the hill of Almontschuk, which I estimated (vol. I, p. 207) at 10 m. high, judging by the eye; but Tschernoff says that it is 9 sashen high (19 m.), though I doubt whether he measured the actual vertical height. He states that the circumference at the base measures 117 sashen.

From that point the expedition returned to Tscharklik by the route already described. Starting at the above-named Jäkän-okuluk they rode for $2\frac{1}{2}$ hours across the delta land of the Tarim as far as Tikenlik, passing on the way the Girlang-köl (on the ice), Tätir-ilek, Gildermak, and Chan Darinning-osesi.

Whilst waiting at Tikenlik Tschernoff contrived to make a trip to the Maltak-köl lakes, that is the extensive marshy tract, whence such a great part of the water of the Kontsche-darja issues to join the Kuntschekisch-tarim. This marsh and its lakes can only be visited in winter, when they can be approached on the ice. Although the map he made of this lake region is not sufficiently reliable, nevertheless the names will always possess a certain amount of interest, and his list supplements the one which I have given on p. 507 of vol. I.

A ride of 35 minutes to the east brought him to the Bos-köl, which he crossed on the ice in 25 minutes. The observation, that kamisch was growing round its shores, seems to indicate that it had large sheets of open water. Thence after another 25 minutes he reached the Süsük-köl, 15 minutes long, with kamisch and tamarisk-mounds on its banks. Thence again in 5 minutes he reached the Schadang-köl, 10 minutes long, with not only the usual vegetation, but also poplars on its shores. From that point he rode 25 minutes to a large kok-ala from the Kontsche-darja, which flows through the Turkomak-köl, 5 minutes long. Then followed a ride of half an hour to Tarimning-koschluschi-Chodscham Käldining-tägirmäni. After another 10 minutes he came to the Sap-kojdi-köl, half an hour long; on its shores grew toghraks and kamisch, and there were two old satmas. This lake was only 5 min. from the Sora-tökörgen-köl, again half an hour long, but entirely surrounded by kamisch. This last lake is immediately connected with the Kärki-tschökken-köl, 20 minutes long, into which the main volume of the Kontsche-darja is discharged, before dividing itself between the Bos-ilek and the Kuntschekisch-tarim (see fig. 444 vol. I). The lake of Tschangumalak-köl in the same vicinity is quite small. Seven minutes from it lies the Balik-jok-köl, which it took 33 minutes to ride across. This name, which means the No Fish Lake, tells its own story, by suggesting that the water is salt, though only slightly so, for Tschernoff found it entirely frozen over. It is probably one of the extreme outlying lakes of the region next the desert. The itinerary records also the following names, though the lakes themselves were not visited — Tschangel-saldi-köl, Majtu-kaldi-köl, Ansu Kulluning-köli, Babamning-köli, Maltak-köli and Abbas kirgen-köl.

In conclusion I will note some names which were recorded by the travellers from the districts beside the lower Ugen-darja. The point at which the route (3 days) from Laj-su to Kutschar crosses over the Ugen-darja is known as Ak-jarsik. Travelling down the river from that point, you have on its left or northern bank the following names — Süsük-mähällä (a village of 100 ujlik), Ak-dung-tscheke (20 ujlik); Tscheke-jinek, Kosch-toghrak-tscheke, Usun-tokaj-tscheke, Örmek-tscheke (2 ujlik), Jigde-basch-tscheke (2 ujlik), Ujup Baj-ujdake-tscheke (1 ujlik), Tschangelik, Tschong-kemidake-tscheke, Jartu-puka-tscheke, Usun-tätir-tscheke, Arik-baschi (1 ujlik), Kongur-tschak-tscheke, Daschi (5 or 6 ujlik), Chat-kojdi-tscheke, Palta-tüschken-tscheke, Egri-köl, Jäkän-köl-tscheke, Jolbars-baschi (with örtäng), Avul Alining-kotan-tschekesi, and finally Jarkent-darjaning-koschluschi, i. e. the confluence with the Tarim, which in that part of its course is often called also the Jarkent-darja. On the southern or right bank the names are as follows: Jantak-tscheke, Ismail Bajning-uji-tscheke (2 ujlik), Dung-kotan-tscheke (10 ujlik), Kum-tscheke, Bujun-kum-tscheke (3 ujlik), Mamuschning-ujdake-tscheke (1 ujlik from Korla), Kader Bajning-ujdake-tscheke (1 ujlik), Tschong Aghetschadake-kum-tscheke, Kitschik Aghetschadake-kum-tscheke, Bure Kurban-tscheke, Akisch-köl-tscheke (1 ujlik of Lopliks), Tscherek-tüschken-tscheke, Usun-ilek, Karaulning-ujdake-tscheke (10 ujlik), and Jarkent-darjaning-koschluschi. Nearly all these are the names of forest tracts at the bends of the Ugen-darja.

Finally Tschernoff's notes contain various measurements of the extent to which the water had subsided since the formation of the ice. But of these I will cite only two. Since the preceding summer the Adoke-kok-alasi had risen 154 cm. This I was easily able to check, because my guide Kirghuj Pavan saw the stream on both occasions. Thus this river-arm had quadrupled in breadth. This appears to furnish a fresh proof of the tendency that the Tarim shows to flit to the east, a tendency which since my last visit to that region has no doubt become much more pronounced. Tschernoff also reports that the Basch-köl had risen to an unprecedented extent since I saw it in December 1899, that is after its inflow canal was opened. Several of the poplars which we then observed growing on the bank were at the time of Tschernoff's visit sticking up through the ice a good bit away from the new shore-line, which then ran close in under the dune-wall.

Imperfect and fragmentary though these reports are, they are nevertheless possessed of great interest. Not only do they prove that the information which I received about the country below the Ullugh-köl and the Begelik-köl was incomplete, they also witness to the fact that the characteristic marginal lakes embedded in the sand extend, and with the same degree of frequency, all the way down to Arghan, though in point of area they appear to be smaller, and in point of shape more irregular, than those above the lakes just named. Further, these marginal lakes lower down the river would appear to possess a more abundant vegetation. Almost all of them still contain water, although the Tarim is beginning to desert its bed immediately along the front of the sand. From this it may be inferred that the river has shifted its bed at a date so recent that the marginal lakes have not yet been able to dry up, nor yet to grow sufficiently salt to interfere appreciably with the formation of ice. The calculations of area and volume which I made in vol. I for the lakes that I visited are plainly not exaggerated, when it is recollected that those lakes are more in number than I assumed them to be. It is however difficult to say how many lakes have to be added to my list of 35 in consequence of Tschernoff's investigations, for in many cases two or more of his names indicate different basins in one and the same lake. The particulars in this chapter, whatever they are worth, may therefore be regarded as a provisional supplement to my own work.

# CHAPTER XXXVI.

## GENERAL HYDROGRAPHICAL RELATIONS OF THE TARIM-BASIN.

In the first volume of this work I have given an account of the lower Jarkent-darja, the whole of the Tarim, the intricate arms and channels of the Tarim delta, the eastern waterway through the lakes which is so intimately connected with the Kontsche-darja, the marginal lakes of the Tarim, and the lower Tschertschen-darja, as well as the lake of Kara-buran connected with it. In the first half of this second volume I have described the old dried-up bed of the Tarim, the Kuruk-darja, and the abandoned lake of Lop-nor so intimately associated with it, and finally the present terminal lake of the Tarim, the Kara-koschun, and the newly formed lakes between that lake and the Lop-nor. Having thus dealt with all the materials in detail, it will be expedient, before proceeding further, to take a brief, but general, *résumé* of the river-system as a whole. The temptation is, I confess, strong, to deal with this subject exhaustively, that is to say, to take into account those parts also of the principal river and its tributaries which are situated amongst the girdle of mountains that ring round the basin of East Turkestan on every side except the east; but the task would demand more time than I can conveniently spare, and would, besides, carry me beyond the limits that I set myself for this present work. All that can be expected of me is that I should make available the materials I have collected. The discussion of these, in conjunction with such information as existed already about the upper courses of the rivers in question, I must leave to the geographers who study such things at home. And even for the geographer who possesses an exhaustive knowledge of the whole of the available material, and so is in a position to arrange and group all the observations which have been made during the last few dozen years by a fairly respectable number of explorers in the peripheral mountains, it will be anything but an easy task to compare and collate the upper courses of those rivers with their lower courses, and to analyse the laws under which their volumes decrease as they advance from the periphery towards the centre of the East Turkestan basin. One reason why it is not easy is that our knowledge of the peripheral parts of the area is in fact still rather deficient. For, while some regions, especially the Tien-schan, where amongst others Dr. Max Friederichsen has quite recently made exceptionally important observations, are well known, other regions are on the contrary but little known, a remark that applies with especial force to certain parts of the Kwen-lun. We are indeed acquainted in broad outline with the orographical arrangement, and even with the positions of the rivers amongst the mountains. But what do we know about the volumes of the rivers at different seasons, and about the relation of the volume to the precipitation, and of the precipitation to the other climatic factors? Little or nothing. Without arithmetical data we cannot in this connection proceed far; and especially of the volume of a river nobody but a trained observer is able to form even an approximate estimate, and yet how often do even such observers make mistakes. From the conventional phrase: «The river made a big and noble stream», it is impossible to deduce any conclusion, for there exists a strong temptation to call every river «big and noble» that occasions difficulty in crossing over it, as may indeed happen with quite a small stream. If, on the other hand, the crossing is effected under favourable and easy conditions, the traveller is apt to forget the true dimensions. But a description which tells us that «the river was at least 50 m. broad, a couple of meters deep, and that the current moved as fast as a horse walks», however defective it may be, does nevertheless give us some idea of the dimensions. But in the case of the upper waters of the hydrographical system of East Turkestan, even such succinct statements as this are all too rare, whilst of accurate measurements there are none whatsoever. In this respect therefore we have practically no data to go upon. All that one can say, speaking generally, with regard to a river like the Tarim, is that, when in its lowermost reaches, and at such an immense distance from its gathering-grounds, it still carries a volume of 140 cub.m. in the second, it must obviously be a stream of considerable magnitude in its upper course. For example, the Raskan-darja or upper Jarkent-darja is at Tong in spring several times bigger than the Tarim is at Jurt-tschapghan at the season of high water; and the Kontsche-darja, the continuation of the Chajdu-gol, has at Korla constantly the same volume as I have assumed for the mean volume of the united Tarim at Jurt-tschapghan. Nor can the united Tarim, with all its tributaries to help it, ever rival in volume that which the Ak-su-darja carries at its mouth at the period of high flood. In other words, the volume decreases rapidly from the sources towards the terminal lake, the reason being that the rivers, which go to make up the Tarim, do not receive a drop of water after they have once entered the lowlands, and have to sustain a fierce struggle against not only the drouthy deserts, but also the arid atmosphere. The former rob them of a considerable percentage of their volume all the way down, but especially in those parts in which the river has shifted its bed, leaving behind it an old, moist channel with plenteous forests beside it, while its new path is dry and absorbs vast quantities of water, and forests are perhaps entirely absent on its banks. But as the shifting of the bed is characteristic of the Tarim all the way down from the mouth of the Ak-su-darja, it is sufficiently obvious that this is one of the chief causes of the serious decrease in the volume of the river in its lower course. In a similar way the Tarim is deprived of immense quantities of water by the marginal lakes, for they vastly enlarge the area of evaporation. Moreover at the low-water season, when most of them are cut off from the river, they shrink rapidly, and consequently, when the high water comes, they have to be filled up again, and it is only when this has been done that the retarded stream is able to continue its journey unhindered to the terminal lake. After this lake is filled, and the Tarim begins to drop, several of those marginal lakes restore to it a portion of the water which they had previously deprived it of, though, owing to the heavy evaporation which has meantime been proceeding, the amount they so contribute is small; in fact the evaporation proceeds as a rule at an equal pace with the subsidence of the river. On the other hand the origination of the boldschemals, or abandoned river-loops, can produce no great effect upon the diminution of the stream. Theoretically their effect ought to be exactly opposite to that of the two factors before mentioned, because they contract the evaporation area; but then, on the other hand, every time a boldschemal is formed it is counterbalanced by a fresh river-bend in another place, and as this procedure is in operation all the way down the river without cessation, its two phases may be regarded as neutralising one another. Hence it may be said that the structure and conformation of the bed of the Tarim are among the principal causes of the rapid diminution of its volume. In this respect the situation of the Tarim is incomparably less favourable than, for example, the situation of the Raskan-darja. This last flows between stupendous mountain-ranges in a deeply sunk valley, and is thus deprived of all opportunity to change its bed. And not only is its channel prescribed for it once for all, but it is always so saturated that the amount of water which it absorbs is small. It is quite impossible for marginal lakes to originate beside it. In consequence of the conformation of the valley, the stream is very deep in proportion to its breadth, and it flows with great velocity. Moreover the mountain atmosphere is moister and the river is shaded by the mountains themselves. In a word, everything conspires to preserve the volume which rolls down the bed of this stream, and it is moreover augmented as it proceeds by the inflow of all its contributories. Now this augmentation from the source down to the point where the last tributary is received takes place wholly within the montainous region, but from the latter point the volume decreases, and decreases at a rate which grows continuously more rapid in proportion as the lowlands become flatter and the desert areas through which the river flows become more extensive. The moment therefore the river emerges into the lowlands, it is deprived of the different species of protection which it enjoyed amongst the mountains, and becomes fully exposed to the forces that work for its destruction. In fact so rapidly do the destructive factors assert their supremacy over it, that it would be completely annihilated before it reached the Kara-koschun, were it not for the cooperation of its largest tributaries. Alone the Jarkent-darja would never under any circumstances succeed in getting down all the way to the Kara-koschun. It is the Ak-su-darja which infuses new life into it, and in virtue of this fresh impulse which it thus receives it does succeed in overcoming all hindrances and in surviving the drain of the many parasites that prey upon it. As compared with these two rivers, the other streams of the system play only very subordinate parts. Both the Kaschgar-darja and the Chotan-darja are only able to get down to the main stream of the Tarim for a very short period in each year. The former unaided would hardly be able to reach as far as the mouth of the Ak-su-darja, and the latter unaided would certainly die away before reaching Tschimen. If the Kontsche-darja had no connection on the way with the Tarim, it would be little likely to penetrate right down to the Kara-koschun. The Tschertschen-darja is the only one of the tributaries of the system which is powerful enough by its own efforts to reach the terminal lake, and that is only because its source is relatively near. How far the Kontsche-darja possesses a corresponding degree of power it is difficult to say, because at several points — in the Kuntschekisch-tarim, the Tschivilik-köl, and the Kara-köl lakes — it mingles its waters with those of the Tarim; besides, the measurements which I possess of this river are all too few to warrant any reliable conclusion. Nevertheless such numerical data as do exist are interesting, and suggest a train of thought which I will here insert by way of parenthesis as an appendix to what I have already said above (p. 7 and ff.) about the Kontsche-darja.

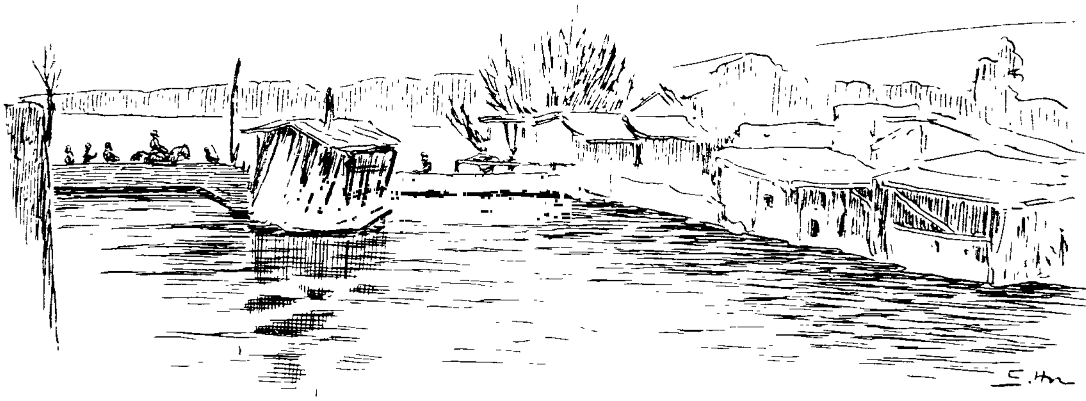


Fig. 237. THE BRIDGE AT KORLA WHERE I MEASURED THE KONTSCHE-DARJA IN 1896.

On 11th March 1896 I ascertained that the Kontsche-darja had at Korla a volume of 71.72 cub.m. in the second, although the Chajdu-gol on the 12th March only delivered into the Baghrasch-köl a volume of 53.5 cub.m. Thus the lake discharged 18 cub.m. more than it received. Now from what I saw at the bridge at Korla, and from what I was told by the natives, I understand that the river preserves at the point indicated the same level winter and summer alike, year after year, and therefore I conclude that the Baghrasch-köl acts as a regulator, equalising the oscillations of the Chajdu-gol, for its volume does of course vary from season to season in the same way as that of all the other rivers of East Turkestan. Hence the volume of the Kontsche-darja may be regarded as constant. At Dilpar on 6th March 1900 this river had a volume of only 32.7 cub.m., and had therefore on the short stretch of 150 km. (disregarding the windings) lost more than one-half of its volume. All the same it would be rash to infer from this, that this rate of diminution of volume continues throughout the entire course of the river — putting aside its connection with the Tarim — down to the terminal lake of the basin, which lies about 320 km. below Dilpar. *If* however that rate of decrease of volume were maintained, the water of the Kontsche-darja would not be able to get farther down than to the Tschivilik-köl or the Kara-köl. I attribute the great decrease I have noted above to the formation of the ice, which of course arrests and, as it were, ties up large

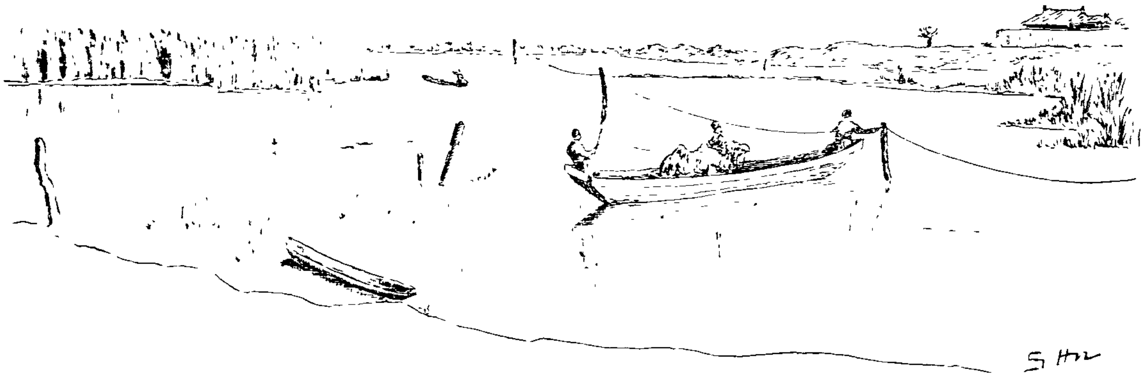


Fig. 238. THE FERRY OF TURFAN-KARAUL. IN THE BACKGROUND THE KONTSCHE-DARJA. TO THE RIGHT THE STATION-HOUSE, 27 MARCH 1896.

quantities of water. I also ventured to suggest (p. 10), that when all that ice melts in the spring, it must give rise to a considerable flood, in the same way as the breaking up of the ice does in the Tarim. And that this suggestion is sound is proved by a measurement which I made in the Kontsche-darja not far above Tikenlik, and about 70 km. below Dilpar, on 27th March 1896, when I found the volume to be 69.6 cub.m. in the second, or reckoning from Korla a diminution of only 2 cub.m.; at the time I attributed (*Peterm. Mitteil.*, Ergänzhft 131, p. 77) that insignificant decrease to the thawing of the ice, which thus took place about the middle of March. Now this imposing flood of thaw-water flows past at a pretty swift rate, and once its maximum has been attained, the river goes on falling all the summer. In the beginning of May 1900 I measured a volume of only 33 cub.m. in this river, namely 19 cub.m. in all the several arms together which in the vicinity of Tikenlik go to feed the Kuntschekisch-tarim, and 14 cub.m. proceeding from the Bos-ilek to the Avullu-köl. Thus the volume in the beginning of May was

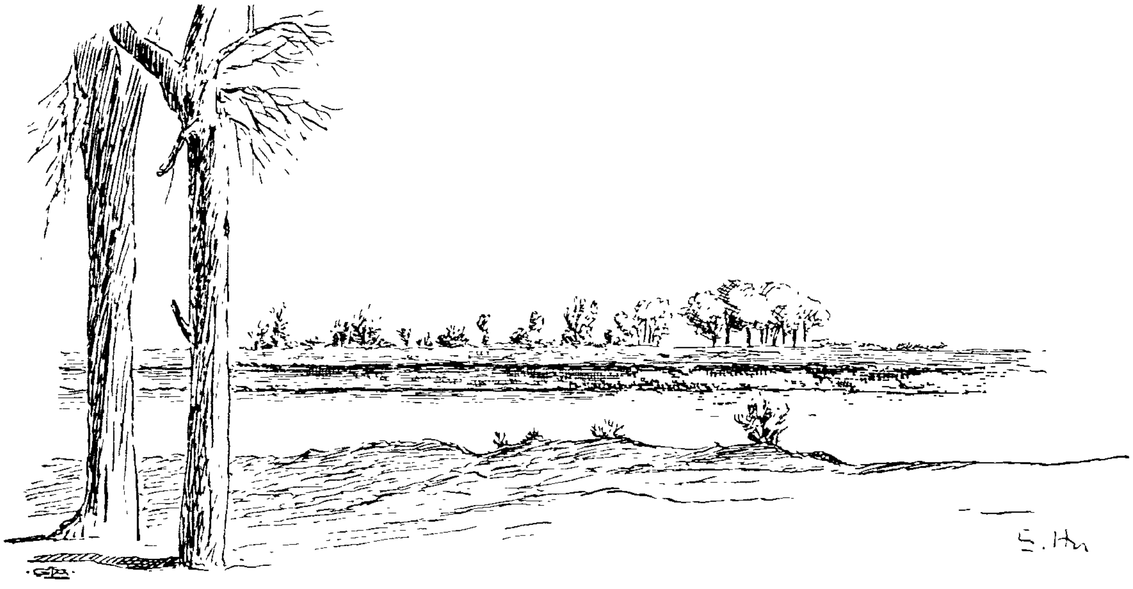


Fig. 239. THE TSCHERTSCHEN-DARJA AT AK-ILEK.

precisely the same as in the beginning of March, though the latter measurement was made a considerable distance below the former: the 19 cub.m. were obtained about 230 km. below Korla, whereas the 14 cub.m. were 280 to 290 km. below the same town. From oral information I ascertained, that this diminution would continue all the summer, although at a slow rate. Even when the river is at its lowest, it is said to contain so much water that it is not possible to ford it on horseback; but it is evident, that what there is flows excessively slowly. The reason why the river decreases so rapidly in spring between Korla and Tikenlik and the Bos-ilek is that all the canals in the district of Korla are then kept open for the purpose of irrigating the cultivated fields. Add to that the quantity of water which is naturally absorbed into the ground, and disappears through evaporation and the formation of the marginal lakes. But even the artificial decrease, caused by irrigation, may be regarded as a constant factor; indeed it seems likely that the region around Korla was in former times more extensively cultivated than it is now, and consequently there was then an even heavier drain upon the Kontsche-darja than there is now. If we suppose the Kontsche-darja to be completely independent of the Tarim, and to flow entirely in its own bed all the way down to the Kara-koschun, then the volume of 33 cub.m. which we find at distances of 230 and 280 km. from Korla would not be able to get down to Kum-tschapghan, which lies 240 and 190 km. respectively still lower down; for the farther the water advances the greater the drain that is made upon it by the surrounding dry, torrid deserts and by the sandstorms with their extraordinarily arid winds, each as desiccating as its predecessor. And it would only be in autumn, after all the irrigation channels are closed, that a thin trickling ribbon of water would be at all likely to reach the terminal lake, and possibly the same thing might be repeated when the ice thaws in the spring. Indeed, when we call to mind how rapidly the Tarim shrinks in the lowest part of its course, it becomes extremely doubtful whether the Kontsche-darja alone would be able to get down as far as the Kara-koschun at all. Anyway it is from this stream that the Tarim receives its last impulse but one towards the maintenance of its powers of resistance; the very last impulse coming from the Tschertschen-darja.

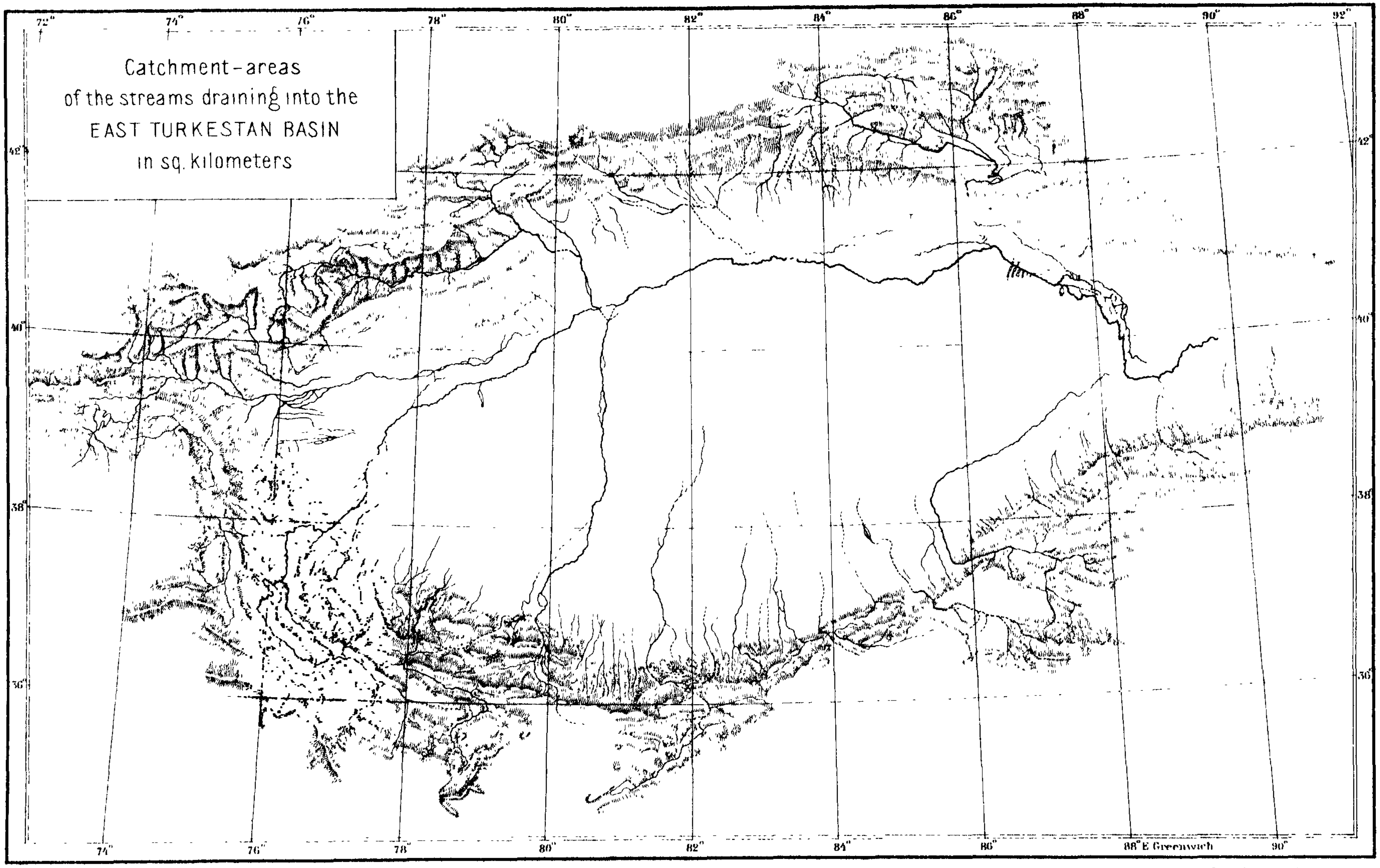
The reasoning just adduced leads to yet another interesting conclusion. If the distance between Korla and Kum-tschapghan amounts to 470 km., and if it is only occasionally that the Kontsche-darja is able to travel the full distance down to the terminal lake, it may be certainly assumed, that the same thing happened in the Kuruk-darja, the distance by it between Korla and the place where it emptied itself into the Lop-nor being 410 km. The distance in the case of the latter stream is indeed somewhat less, but on the other side we have to set the fact that its banks were certainly inhabited in places, because one of the roads to Korla ran beside it, and it is safe to assume that the people who dwelt on its banks also utilized its water for irrigation. If now the stream of the Kontsche-darja, which we may safely say had, sixteen hundred years ago, about the same volume that it has now, for the Baghrasch-köl played then the same regulative and distributive part that it does now, and if the entire river flowed as one stream through the bed of the Kuruk-darja, then, it may argued, the river (1) would never have been able to get down to its terminus south-west of Altmisch-bulak, and (2) even *supposing* it did get down as far as that, its vitality upon reaching that point would be so small that it would have been utterly impossible for it to have scooped out a bed to such an energetic depth as is exhibited by the channel which we see in the desert to-day, and still less would it have been able to originate a lake to which the Chinese applied the name of the *Great* Salt Lake. Here again, then, we have a proof of the contention I have argued for above, e. g. p. 300, namely that the Kuruk-darja formerly carried the entire flood of the Tarim and that the Kontsche-darja was then, just as it is now, nothing more than a tributary of the Tarim. If now Kosloff's idea, that the Kontsche-darja alone formerly flowed through the bed of the Kuruk-darja, and then turned south through the desert to the Kara-koschun (Pl. 35), be compared with what I have just said above, the absurdity of his theory, which rests upon no sort of proof or support whatsoever, becomes even more patent than it was before. By that route the distance between Korla and the Kara-koschun is almost 500 km., and nobody will be so bold as to maintain that the Kontsche-darja, even in times of exceptionally high flood, ever possessed the power of preserving its vitality so far down as that, especially when its flood was drained away at Lôu-lan for irrigation purposes, a fate it now escapes.

By dwelling upon this matter I have not only been able to offer an illustration of the way in which the rivers of East Turkestan decrease in volume from the moment they issue upon the lowlands, but I have also been given another opportunity to prove the untenableness of Kosloff's assumption, that formerly the Tarim and the Kontsche-darja flowed by different routes to the Kara-koschun.

Resuming where I broke off. — The upper courses of the northern tributaries of the Tarim — the Ak-su-darja, the Tauschkan-darja, and the Kontsche-darja — belong to a part of Central Asia with which I am not familiar, and consequently I can only pass them over without saying anything about them. With regard to the streams that rise on the southern border of the basin — the Jarkent-darja, Chotan-darja, Kerija-darja, the rivers of Kirk-saj, and the Tschertschen-darja — their upper courses belong to the Tibetan highlands, and I shall have an opportunity to discuss them when dealing with that part of Tibet in the fourth volume of this work. That region might conveniently be termed the »northern peripheral zone of Tibet», being a belt of country that belongs intimately to Tibet, as well as intimately to East Turkestan. To the former it belongs *a priori*, as forming a part of the stupendous mountain swelling, from which it is merely discriminated in so far as it supports the border-ranges of the Kwen-lun and drains into the Great Central Asian basin of the Tarim; and it is in virtue of this same property that it belongs just as intimately to the basin of the Tarim. To the north of this border zone such precipitation as does fall is excessively small, and under no circumstances does it make even the smallest contribution to the rivers of the Tarim system. If therefore the rainfall and snowfall of this border zone did not gather concentrically towards the central basin, this last would be a complete and continuous desert, without a single oasis. South of this peripheral zone stretches the self-contained basins of the Tibetan highlands, a veritable mosaic of basins, great and small, in countless number, most of them with a salt lake in the deepest part of its depression. The only portion of the pheripheral zone which is not backed by this self-contained drainage basin is that which lies in the extreme west, namely the catchment-grounds of the Jarkent-darja; behind it is a region that drains away to the Indian Ocean, namely the upper basin of the Indus. Here then it is that we have, as also partly in the Pamir, the important divide which separates the water flowing to the great ocean from the water flowing into the Lop-nor depression. As for the catchment-area of the Kaschgar-darja, it touches on the west the catchment-area of the Sea of Aral, namely the upper gathering-grounds of the Sir-darja and the Amu-darja. But in between these two catchment-areas, that of the Kaschgar-darja and the Jarkent-darja on the one side and that of the Amu-darja on the other, there are interposed a couple of self-contained basins, namely the large Kara-kul and the Rang-kul.

Though, as I have already observed, the basin to the north of the peripheral zone of the Kwen-lun may be considered as entirely lacking in precipitation, this is by no means true of the highland region to the south of it. For, as I shall have occasion to show when I come to describe Tibet, and as my meteorological journal will sufficiently corroborate, both rain and snow do fall there, especially in the warm season of the year. Confining our attention to the self-contained drainage-area of the highlands, it may be said, generally speaking, that the precipitation increases in quantity from north to south and from east to west. The latter half of the statement, namely that the precipitation increases from east to west, applies also to the peripheral zone, as is shown by the accompanying sketch-map of the catchment-areas (Pl. 57). True, the sketch does not convey any direct information as to the quantity of the precipitation; but the very fact of steady decrease in the magnitude of the big rivers from west to east suggests the existence of the law I have stated. In the extreme west we have the Jarkent-darja, the biggest stream of all; next comes the Chotan-darja, which only reaches the Tarim during about forty days in the year; then follows the Kerija-darja, which has long been cut off and dissevered from the main artery of the system; the remaining streams — the Sourghak-darja or Nija-darja, the Tolan-chodscha, the Bostan-toghrak, the Möldscha, and the Mit or Kara-muran — are all still smaller. The Tschertschen-darja forms, it is true, an exception; but the streams to the east of it, that flow north, and of which the Tscharklik-su is the largest, are all of incomparably less magnitude than even the rivers of the Kirk-saj. Now although these extreme easterly streams do lie so near to the terminal basin of the Tarim system, they nevertheless all alike fail to reach it. From the catchment-areas of these streams, no sound conclusions can be drawn directly with regard to the precipitation; for, while the Kara-muran drains an area of 18.000 sq. km., the Bostan-toghrak and the Möldscha together drain an area of 13.200 sq. km., and yet each of the last-mentioned streams is at least as big as the Kara-muran. The catchment-area of this river, again, is rather greater than that of the Tschertschen-darja, and yet the latter is incomparably greater than the Kara-muran, as my description in vol. I will clearly show. The circumstance is however curious, for the two drainage-areas are immediately contiguous the one to the other.

If now it is the precipitation, both the direct and the indirect, that is to say the freshets formed by the thawing of the snow and ice, that determines the different magnitudes of the rivers in question, it is equally the last named, or more correctly the power of its erosion, which prescribes the varying areas of the catch-



Catchment-areas
of the streams draining into the
EAST TURKESTAN BASIN
in sq. kilometers

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ment-basins. A river like the Jarkent-darja possesses of course to an incomparable degree a greater power of enlarging its catchment-area than does, for instance, the Kerija-darja. Under any and every circumstance therefore the gathering-grounds of the latter stream must of necessity cover a smaller area. In this way the amount of the precipitation, the dimensions of the several rivers, and the areas of their respective catchment-basins must be proportionally related the one to the other. For this reason the breadth of the peripheral zone of the Kwen-lun must increase towards the west. To a certain extent the same law would appear to hold good with regard to the southern peripheral zone of the Tibetan plateau where the catchment basin of the Indus broadens towards the west all the way from its origin near the lakes of Manassarowar.

The following table of the catchment-areas of the streams draining into the East Turkestan basin makes no claims to strict accuracy, for we do not possess sufficiently accurate maps of the peripheral zone; still it will serve to give an approximate idea of the relative size of the different areas. The calculation has been made with the help of a polar planimeter on sheet 62 of *Stielers Handatlas*. The very smallness of the scale on which the map is drawn precludes any great accuracy of detail; nevertheless the sheet in question is the best general map of Central Asia that we as yet possess. The first step was to prick out the boundaries of each catchment-area, that is to say the upper parts only of each individual stream, within which it may be supposed to receive feeders from the mountains. The upper boundary, the water-parting, admitted of being followed with relative certainty; but with regard to the lower boundary, the dividing-line between the gathering-area and the lowlands, considerable uncertainty exists, and the boundary in that direction is to a large extent pure guess-work. Yet for the object we have here in view, the results may be regarded as being sufficiently accurate. I have of course given them in round numbers.

| River. | | Area in sq. km. |
|---|---|---|
| Kaschgar-darja | | 56.000 |
| Ak-su-darja and Tauschkan-darja | | 42,000 |
| A small area between these two | | 8,000 |
| The Tien-schan between the Ak-su-darja and the Chajdu-gol | | 38.000 |
| Chajdu-gol (down to Baghrasch-köl) | | 32.000 |
| Baghrasch-köl | | 8.000 |
| Jarkent-darja | | 64.000 |
| Kara-kasch | Chotan-darja | 21.000 |
| Jurun-kasch | | 16,000 |
| A small area between the Jarkent-darja and the Chotan-darja | | 12.000 |
| Kerija-darja | | 16.000 |
| A small area between the Jurun-kasch and the Kerija-darja | | 10.000 |
| Nija-darja, Tolan-chodscha, and several other small streams | | 15.000 |
| Bostan-toghrak, Möldscha, and several minor streams | | 13.000 |
| Kara-muran | | 18.000 |
| Tschertschen-darja | | 17,000 |
| The small brooks of the Astin-tagh from Kum-bulak onwards | | 30.000 |
| Kuruk-tagh | | 30,000 |

The difficulty of drawing anything like a reliable boundary is greatest in the east. We do indeed know, and in vol. III we shall learn more fully, that a number of glens, some of which sometimes carry streams of water, cut their way through the Astin-tagh northwards to the lowlands, and the Kum-bulak is by no means the last of them; but it is difficult to draw the dividing-line between those that flow down to the Kara-koschun and those that go to the Chara-nor. And yet this is, after all, a matter of little moment, for the eastern extremity of the peripheral zone is for our immediate purpose *une quantité négligeable*, in that it makes no contribution whatever to the maintenance of the terminal lake. I have not entered on the map the corresponding part of the Kuruk-tagh, that is to say the eastern extremity of the northern peripheral zone, for the simple reason that our knowledge of its geography is so very defective, it is not possible to lay down any sort of hydrographical boundaries at all. Let us assume however that the part which drains into the Lop depression, or speaking generally into the Tarim basin, is equally as large as the corresponding area on the south, or say 30,000 sq. km. This region again is a factor that may be disregarded entirely, for it does not send down a single stream from the Kuruk-tagh to the Kontsche-darja: the brook of the Suget-bulak, that of Kurbantschik, and that of the Budschentu-bulak all alike fail to reach the river.

Yet even though, as I have already pointed out, the figures in the table given above are not trustworthy in detail, still it is fair to assume that the sum of all the areas put together is not very far from the true area. The total area therefore of the region which drains into the Tarim basin is 446,000 sq. km. But that part of its basin from which the Tarim and its daughter streams do not receive a single drop of water possesses almost exactly the same area, namely 471,000 sq. km. Now not only this proportion between the contributory and the non-contributory parts of the basin, but also the morphological and hydrographical arrangement of the system as a whole, may be regarded as being in the highest degree unusual and peculiar. With regard to the symmetry of this conformation, there is scarce another hydrographical basin in the world that can compare with it. In Tsajdam, for instance, it would be hard to detect any trace of symmetry whatever. Some of the small basins of Northern Tibet are indeed fairly symmetrical, but their arrangement is very simple. Small torrents gather from north and south off the mountain-ranges and from east and west off low latitudinal thresholds or transverse ridges, and meet to form a salt lake — a type of basin that is in fact very common in Tibet, and which in point of orographical formation is repeated to a monotonous extent. In shape all these basins are elliptical, and in arrangement concentric throughout. In the Tarim basin the arrangement is however excentric, its deepest depression being situated a long way in the east; in fact it is so far to the east that it almost falls outside the boundaries of the regular ellipse. On the other hand the hydrographical arrangement is, as I have already said, exceptionally symmetrical. If the deepest part of the basin lay beyond the long axis of the ellipse, the symmetry would be ideal; but, situated as it is at the southern foot of the Tien-schan, it has occasioned a dislocation towards the north of the main stream of the system, though that in no wise disguises the striking lines of the symmetry, which are of course occasioned by the positions of the encircling mountains. If we compare the northern peripheral zone from the catchment-area of the Kaschgar-darja to the catchment-area of the Kuruk-tagh, both inclusive, with the southern peripheral zone from the catchment-area of the Jarkent-darja to the catchment-area of the Astin-tagh, both again inclusive, we find that the former has an area of 215,000 sq. km. and the latter an area of 232,000 sq. km., or in other words that they are approximately of the same size. In the case of both the breadth decreases on the whole towards the east, until they each terminate in a narrow strip, the domain of the Kuruk-tagh on the one hand and that of the Astin-tagh on the other. But before they contract in this way the zones swell out into the Chajdu-gol and the Tschertschen-darja + Kara-muran respectively, the catchment-areas of which in point of both area and breadth exceed the catchment-areas of the rivers to the west of them. A corresponding symmetry can also be seen in the rivers which gather off the encircling mountains into the depression. In the extreme west we have the Kaschgar-darja belonging to the northern zone and the Jarkent-darja belonging to the southern. Then follows on both sides a wide gap in which there are no rivers. Instead we have on the north a tract of arid, barren desert, crossed at intervals by low mountain chains, and on the south the Desert of Takla-makan proper, with its appalling ocean of sand. After that come a couple of rivers, the Ak-su-darja on the north and the Chotan-darja on the south, which have their courses tolerably near together. But while in the Kaschgar—Jarkent-darja the larger river and the larger catchment-area lie to the south, in the Chotan—Ak-su-darja the larger river and the larger catchment-area lie to the north. And as, interpolated between the Kaschgar-darja and the Ak-su-darja, there occurs a small distinct area belonging to neither, so also there is a corresponding independent area between the Jarkent-darja and the Chotan-darja on the other side of the basin. And the parallelism extends even farther still; for, while the northern river is formed by two powerful upper branches, the Tauschkan-darja and the Ak-su-darja, the southern is likewise formed in a similar way out of the Kara-kasch and the Jurun-kasch. The next intermediate region on the north of the basin is the barren desert between the Kutschar road and the forest belt of the Tarim, to which there corresponds on the south the desert of Kerija, a tract possessed of the same properties as the Takla-makan. After that comes the next pair of rivers, namely on the north the Mus-art-darja or Schah-jar-darja and on the south the Kerija-darja. East of these follow the two largest of the intermediate areas, in which the rivers are so small that they hardly reach down to the caravan roads on the north and south respectively, to say nothing of their travelling across the adjacent deserts. Finally, we have the last pair of rivers, the Chajdu-gol (Kontsche-darja) on the north and the Tchertschen-darja on the south, which join the main stream not very far from one another. Both are fairly equal in point of magnitude; for, though the Kontsche-darja carries the bigger volume, it has a longer distance to travel from its sources, and consequently experiences a relatively greater degree of exhaustion on the way. The Kerija-darja is undoubtedly a more powerful stream than the Tschertschen-darja; for, while its catchment-area is somewhat less, it receives in consequence of its more westerly situation a heavier amount of rainfall. The oasis of Kerija is however far more populous than the oasis of Tschertschen; consequently a greater amount of water is drawn off from the Kerija-darja by irrigation than from the Tschertschen-darja. As a consequence of this, as also of the relative proximity of the latter stream to the main artery of the system, the Tschertschen-darja occupies a more favourable situation than the Kerija-darja does, and seeing that it not only reaches all the way to the main river, but also possesses its own terminal lake, namely the Kara-buran, it gives the impression of being the greater of the two streams. And yet this impression is not warranted by the actual facts. The Kerija-darja is, from Kerija to the point where it terminates, almost as long as the Tschertschen-darja from the town of Tschertschen to the Kara-buran. Several parasites however prey upon the first-named, and it loses its flood not only through irrigation but also because it adventures itself out amongst the destructive agencies of the dry sandy desert, where it becomes exposed to the effects of the drift-sand to a far greater extent than the Tschertschen-darja does, the position of which, running parallel to the prevailing wind, favours it still further.

Similarly, the Ak-su-darja has a more favourable position than the Jarkent-darja: the distance which the former travels to reach the Tarim is so short, whereas the latter is forced to cross over a large desert before it can join the main stream. The same is true of the Chotan-darja. In the end of June I found that the Jurun-kasch carried an extraordinarily big flood, so big in fact that it was impossible to ford it on horseback; but in the beginning of the same month I forded on horseback both the Ak-su and the Tauschkan-darja, although not very easily. The catchment-area of the Ak-su-darja amounts to 42.000 sq. km., and that of the Chotan-darja to 37.000 sq.-km.: the difference therefore between the two rivers in this respect also is not particularly great. What makes the Ak-su, upon reaching the Tarim, incomparably so much greater than the Chotan-darja when it reaches the Tarim is simply and solely its geographical position, coupled with the fact that the oasis of Chotan is far better cultivated than the oasis of Ak-su. The distance from the junction of the two large headwaters of the Ak-su to the point where the united stream falls into the Jarkent-darja (Tarim) amounts in round numbers to 95 km.; from the confluence of the Kara-kasch and the Jurun-kasch to the point where the Chotan-darja issues into the Tarim the distance is 290 km., or three times as long. This last confluence lies however a good long way out in the desert, so that it would be better to compare the distances of the two belts of oases from the principal river. This in the case of the Ak-su amounts to 115 km., but in the case of the Chotan-darja it is 435 km., or nearly four times as great. It is in this part of its course, whilst making its long journey across the desert, that the Chotan-darja becomes so exhausted that it is only with difficulty it does succeed in making its way to the Tarim, whereas the northern stream is scarcely drawn upon at all before it reaches the same goal. If the two streams be compared from their respective belts of oases upwards to their sources, then the Ak-su-darja is unquestionably a more powerful river than the Chotan-darja. Not only is there probably a heavier precipitation over its catchment-area, but its snowfields and glaciers are more directly exposed to the midday sun, so that a relatively greater amount of snow and ice is converted into water than in the source-region of the Chotan-darja, where, again, on the other hand evaporation appears to play a relatively more important rôle. One thing is however certain, namely that if the deepest part of the basin lay at the foot of the Kwen-lun, and if, as would then be the case, the Ak-su-darja had to traverse the entire desert before reaching the Tarim, it would be the Chotan-darja that would appear to be the more powerful stream of the two. From this it results, that we err, when we estimate the magnitudes of the different chief tributaries of the Tarim by the distances they have to travel respectively across the lowlands. Previous to 1896 the Kerija-darja in particular was very much underestimated, for it was reputed to proceed little more than a score or two kilometers north of Kerija; but upon travelling down beside it, I found that it reached a good bit beyond the 39th parallel of latitude. Generally speaking too, the effects of the irrigation drain are misleading, and with the exception of the Ak-su-darja and the Tschertschen-darja, it is pretty certain that all the large rivers of East Turkestan appear to be less than they really are precisely because there is such a heavy drain upon them through the irrigation canals.

Nor do these resemblances between the Kontsche-darja and the Tschertschen-darja exhaust the symmetry of arrangement that obtains in the gathering basins of the encircling mountains and in the pair-wise grouping of the rivers, but they extend also to the terminal lake, which is, so to speak, double, or rather the principal river empties itself alternately into two different depressions, first into the northern depression of the Lop-nor and then into the southern depression of the Kara-koschun. Hence originates what I have ventured to describe as the pendulum-like oscillation in the changes of the lowest part of the Tarim. At the present time the terminal lake lies in the southern part of the basin, although the greater part of the Tarim belongs to its northern side. But everything points to its having begun a new pendulum-swing back towards the north.

Of the two largest constituent streams of the Tarim, I have come to the conclusion, that the Jarkent-darja ought to be regarded as the mother-river, the true main artery of the system, and this not only in virtue of its length but also of its more extensive catchment-area, while at the same time I have also been led to the conviction, that it is the Ak-su-darja which contributes the greater volume to the Tarim. Now even though the Kaschgar-darja be reckoned, as I have here reckoned it, to the northern peripheral zone, and if the Mus-art-darja contributes, as it does contribute, a considerable volume to the Intschkä-darja, and if the Kontsche-darja is a more powerful river than the Tschertschen-darja — nevertheless all this ought not to mislead us into believing that the northern peripheral zone contributes a greater volume of water than the southern peripheral zone, or in other words has a heavier precipitation. The reason that this appears to be so is solely the fact that the Tarim flows so close to the foot of the northern peripheral zone. I am almost inclined to believe that it is the southern peripheral zone which has the heavier precipitation, if for no other reason than for this, that it lies nearer to the monsoons that blow in off the Indian Ocean, at any rate the southern peripheral zone feels the effects of their moisture more than the northern peripheral zone does. We are prone to overlook the Kerija-darja and the rivers of the Kirk-saj, because they are cut off from the main system and isolated from it, although hydrographically they still belong to it *de facto*. And yet enormous quantities of water flow down their beds in spring and summer, all of which is swallowed up in the sand, for none of these streams is able of its own power alone to penetrate right across the desert. The future must answer the difficult questions as to the relations which exist between the precipitation on these mountains and the magnitude of the rivers. All that can safely be said theoretically is, that an exceptionally heavy precipitation in the peripheral mountains must of necessity be followed by an augmentation in the rivers and an enlargement of the Kara-koschun. The same effect is produced by a warm, bright summer following upon a snowy winter. But what do we know about it, seeing how seldom the country in which these phenomena occur is visited by Europeans, and then in but a fugitive manner! The persistent shrinking of the Kara-koschun points to the existence of a climatic periodicity; but it may equally well be caused by an increase in the number of the marginal lakes on the right side of the lower Tarim, as also by an extension of agriculture. These problems however I can only thus briefly touch upon, I cannot attempt to solve them.

In skeleton outline the plan of the Tarim system resembles a drooping birch, as contrasted with the pine-like Indus and the palm-shaped outline of the Amu-darja and Sir-darja, and thus is very different from the peculiar Indo-Chinese rivers, which, after having gathered up their waters in Eastern Tibet, cut their way through deep, long, fantastic gorges through the mountains. The Kara-koschun is the root of the tree, the Tarim its trunk, and the various tributaries its branches, while the catchment-areas of these last would pass for the clusters of foliage. The Kerija-darja, the rivers of the Kirk-saj, and several others are branches withered and cut off. The functional activity of the river-system works however in a direction opposite to what it does in the tree. For whereas in the latter growth proceeds from the root upwards, and the sap rises through the trunk, and penetrates thence into the branches and leaves, in the river-system the »sap» gathers first in the remotest tentacles, and flows downwards through the branches and the trunk, so that it is through its peripheral activity that the terminal lake is maintained. It is true, the Amu-darja and the Sir-darja flow across burning deserts on their way from their source-regions to their terminal lake, but in their case how different is the entire hydrographical arrangement! Their gathering-grounds form a compact territory, from which the united stream gradually advances. On the other hand the main artery of the Tarim system is surrounded on all sides except the east by its source-regions, so that it thus flows within a ring of mountains. Throughout the whole of their long course across the desert the two rivers of West Turkestan are joined by practically no tributaries; whereas the Tarim on the contrary receives almost at the end of its course the two large affluents of the Kontsche-darja and the Tschertschen-darja. And yet the same law holds good in the basin of the Tarim that holds in the basin of the Aral, namely that as soon as the rivers issue into the deserts of the lowlands they receive no augmentation of volume, but on the contrary decrease rapidly down towards their respective terminations. The only difference is that each of the affluents of the Tarim ought to be separately compared with the Amu-darja and the Sir-darja. In this respect the Tarim alone, the Kontsche-darja alone, the Tschertschen-darja alone, occupies severally the same position as the Amu-darja or the Sir-darja. The shape of the basin of East Turkestan forces the rivers to flow together, and so to become affluents of each other mutually.

# CHAPTER XXXVII.

## CHARACTERISTICS OF THE TARIM TO KARAUL.

In the preceding chapter I have dealt with the broad features of the hydrographical relations of the Tarim basin. In a later chapter I shall discuss its absolute and relative altitudes. In the present chapter I will bring together as succinctly as possible those of its physico-geographical characteristics which may be regarded as being most conspicuous in those parts of the river's course which I explored. In other words, what I am about to set forth is a brief general *résumé* of the information conveyed in detail in vol. I. It will facilitate the use of the map if, instead of citing the geographical names as points of intersection, I use the different encampments we made. I begin therefore with Lajlik, on the 17th September 1899. There the river makes two big bends, contains an abundance of alluvium, possesses a couple of rudimentary boldschemals, and the forest on its banks is young and scrubby. The extent to which the river subsides in the autumn was plainly indicated by steps in the mud-banks formed during the high-water period. From this point and for a long way down the river fishing is not prosecuted owing to the muddy condition of the water; the people live by breeding sheep, and to a slight extent by agriculture.

18th September. The course was straight, except for a couple of bends. In the straight reaches the bed is narrow, the current and the depth uniform, the alluvial formations slight; in the windings the breadth increases, as also do the area of the alluvial deposits and the maximum depth. In places the forest is rather more abundant. The great caravan road to Maral-baschi runs along the left bank.

19th September. A big bend; the forest grows rather denser, though the trees are seldom more than 4 m. high. The high-water reaches Schäschkak on 20th July, and the ice begins to form in the beginning of December.

21st September. In places copious forest, the trees being of medium height; the river sinuous; the depth reaching 5 to 6 m.

22nd September. The river partly straight, partly winding, and narrower than hitherto. In places the forest is fairly thick and vigorous.

23rd September. The bed rather winding and narrow, full of drift-wood, the poplars frequently falling into the stream in consequence of the banks being undermined; this sometimes gives rise to barriers, which help to make the river change its bed. Generally speaking the Jarkent-darja is here more restless and more active. From the deserted channel, the Kona-darja, a big irrigation canal goes off to Maralbaschi, the water being diverted into it in spring by a dam put down at the beginning of the new river, the Kötäklik-darja. In this last the velocity is greater than it has hitherto been, the new channel having been made in 1895 and not yet having formed windings and alluvia. In one place there is a cataract one decimeter high. Forest scanty and rare.

24th September. Ditto — ditto. The windings are only small and insignificant; the bed is deep and narrow, sometimes only 7 to 8 m. across; the terraced banks 1 1/2 m. high; on the left bank, at Ghorung-dung, small sand-dunes with vegetation. Bushes, kamisch, young toghraks standing singly. Cataracts in three places, the last of them 2 dm. high.

25th September. The bed winding but little; the depth reaching down to 6 m.; the breadth in some places only 6 to 7 m. A network of arms, all very short, meet again at the sand-dune of Karaul-dung. At intervals dunes bound by vegetation and 6 m. high. One to two kilometers to the south and south-east the dunes of the Desert of Takla-makan; the surface nothing but sand. Luxuriant forest at Kumatschal only. High terraced banks. The country uninhabited, consequently it yielded only a few geographical names. Generally speaking the banks of the Jarkent-darja, like those of the Tarim, are extremely thinly inhabited; you may often travel for several days without meeting a single human being. Permanently settled localities exist in only a few places, and those mostly beside the lower Jarkent-darja and the Tarim. To the subject of the population I shall however return in a later chapter.

27th September. One bend; otherwise the bed remarkably straight. The Kona-darja reunites with the new river, the old bed being then followed. Solitary dunes, big and barren, at Petelik-otak; the terraced banks up to 3 1/2 m. in height. Depth amounting to 8 m. Magnificent forest, thickets and reed-brakes.

28th September. The bed moderately winding, up to 7 m. deep, old, and energetically eroded; thick, fine forest. A few kilometers south-east of the old arm of Chorum is high sand. A belt of forest, bushes, and kamisch steppe of varying breadth fills the space between the barren sand of the Takla-makan and the right bank of the river all the way down to the confluence of the Ak-su-darja; though the breadth of the forest proper seldom appears to exceed 1 to 2 km. Generally the transition from forest to barren sand is rather abrupt. At the most there is only a strip of tamarisk and scrubby steppe between the two, together with a few solitary poplars. There are often patches of kamisch amongst the nearest dunes.

29th September. The bed very sinuous; small alluvial deposits. Kamisch next the bank. Steppe and bushes predominate; forest is less frequent. Dunes of considerable size at Kanscha-kum. The big sandy desert approaches very close on the south-east. Canoes belonging to the riparian shepherds begin to make their appearance.

30th September. Moderately winding; very slight alluvial deposits; eroded terraced banks up to 4 and 5 m. in height; depth reaching 8 m.; the current narrow and sluggish. Beyond Kijik-tele-tschöl the country is more open and desolate; steppe predominates; no forest, though thin clumps of young toghraks.

1st October. Windings only small; current shallow and swift; breadth about 20 m.; scarce any alluvium at all. Steppe predominates everywhere; bushes and toghraks rare. Two large canals join the river from the Schor-köl. This lake is clearly formed by the overflow of the canal to Maral-baschi already mentioned, though whether the Kaschgar-darja also possibly contributes to its maintenance I do not know. At any rate the Schor-köl lies higher than the Jarkent-darja, for its two canals descend cataracts 1½ m. high. To the north we passed an old bed of the Jarkent-darja, namely the Kodaj-darja, into which water is forced in the spring in order to supply the villages that stand beside it. Here too, below Schamal, another old bed rejoins the main stream. To the north the mountain of Hasret Ali-masar, with a saint's grave. At its foot are huts permanently inhabited.

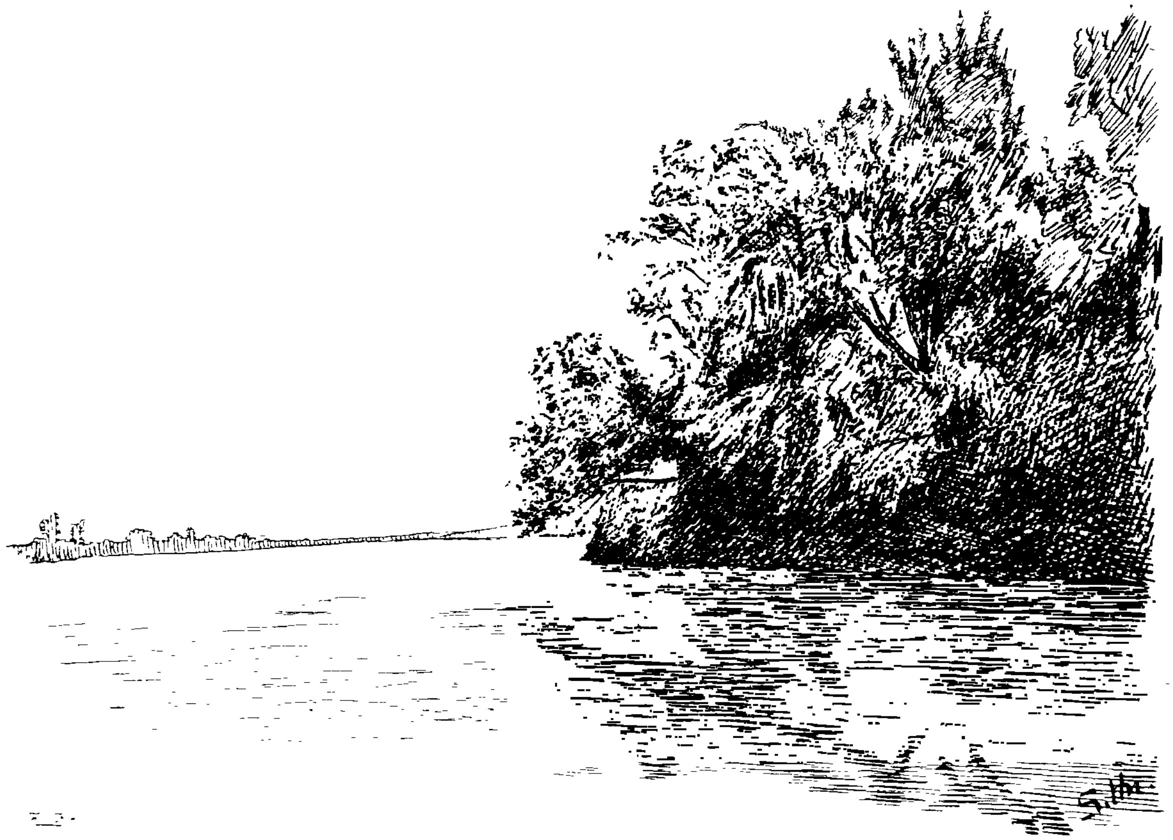


Fig. 240. BANK, WITH FOREST, OF THE JARKENT-DARJA.

4th October. Moderately winding; regular, deep, canal-like bed, without alluvium. On the banks kamisch steppe, and kamisch steppe alone. On the southern bank the lake and marsh of Jughan-balik-köl, and the mountain of Tusluk-tagh, in part over-sanded and with salt deposits, which are exploited by the people of Maral-baschi.

5th October. Moderately winding; nothing but steppe, no forest whatever. On the south the marginal lakes of Sorun-köl and Tschöl-köl, lying parallel to the strike of the Tschoka-tagh, i. e. almost meridional. These lakes, together with the Jughan-balik-köl, and a couple of others farther to the west, which I touched in 1895, are the first of the marginal lakes that deprive the Jarkent-darja-Tarim of its water. And with these, the first group of true marginal lakes, we may include the marsh of Lalmoj.

8th October. A couple of big bends; broad and sluggish current; insignificant alluvia; erosion terraces 1½ m. high; steppe, except for poplar woods east of the Saj-tagh.

9th October. Very sinuous; depth reaching to 8 m. At Kala-dung vigorous forest, otherwise steppe. At Milka sand-dunes, bound together with vegetation.

10th October. Extraordinarily winding; very luxuriant forest. At Ak-satma shepherds permanently established, who grow wheat, which on the whole is rare alongside the main river.

11th October. Extraordinarily winding; very narrow and deep; the breadth in some places not more than 15 m. Underwoods; here and there thick clumps of poplars. Here a large marginal lake, the Jantak-köl, situated not far south of the Jarkent-darja, in the forest-belt between the river and the high sand, though it is invisible from the river. It is probably a marsh rather than a lake, and is more capricious in outline than appears from Pl. 4 of the atlas. It may be assumed, that the belt of forest as a consequence of including this lake is here rather broader.

12th October. Very sinuous; alluvia only at the extreme tips of the peninsulas. In general the river grows narrower and deeper as it proceeds. Narrow strips of forest on the banks. At Dugha-dschaji the containing bank, although 2.08 m. high, is under water at the high-flood season; these local and fortuitous overflows rob the river of a portion of its water. Indeed we may fairly assume, that in years of exceptionally high water these local inundations serve as a sort of safety-valve to the river, keeping down its volume to the normal level.

13th October. Exceptionally winding; forest and steppe alternate. At Toghri-kum on the left bank big overgrown dunes.

14th October. Not so winding as usual in this part of its course; broad, shallow, and containing alluvia. Except that at Ghascha there is old and vigorous forest, steppe predominates. At Jigdelik overgrown dunes on the right bank. The high, barren sand 10 km. distant. Throughout the whole of this region sheep-breeding is pretty actively carried on, although it is only by chance that the shepherds or their flocks were seen.

15th October. For the first half of this stage the river is exceptionally winding, narrow, deep, and sluggish; the latter half consists of a single wide sweeping curve, and in it the stream is broad, shallow, and swift. Plentiful forest, and at Islik old poplars.

16th October. Rather sinuous course. Boldschemals begin to be numerous. Sandy banks terraced to the height of 3 m.; lofty sand-dunes quite common. Only 2 km. to the great sandy desert. Thick and luxuriant forest.

17th October. At first straight, afterwards rather winding. Some large boldschemals. At Kujlusch there enters a small branch of the Kaschgar-darja under the name of the Kara-jilgha-darja. Young forest, underwoods, otherwise steppe. Here a tract with overgrown dunes known as Agis-kum. A couple of old river-beds long since abandoned.

18th October. At first straight, the second half moderately winding; old terraced banks that have been inundated. The river here as it were somewhat undecided.

19th October. Not especially winding. A large boldschemal visible, although here, as indeed elsewhere, there are several that are not visible from the river, being more or less overgrown and hidden by vegetation. On the left bank sand-dunes, which in places are connected with the belt of sand that stretches between the Jarkent-darja and the Kaschgar-darja. From Dung-gerem the high sand of the Takla-makan appeared to lie 10 km. to the south-east.

20th October. Moderately winding; depth up to 6 m.; terraced banks up to 5 or 6 m. high. These terraces, which were then dry, mark the limit of the high water. On both sides old beds of the Jarkent-darja long ago abandoned. Forest in part thick. A strongly marked boldschemal; jarsiks common; extensive alluvial deposits. The ground sandy. A long, narrow belt of sand on the left bank, with pretty big dunes, is known as Kalmak-kum. At Kokul the great sandy desert is estimated to be 12 km. distant. Roads along both banks.

21st October. Not particularly winding; the bed in general broader, so that at that season only a relatively narrow portion of it was covered with water. A large boldschemal visible. Toghrak forest alternates with steppe and dunes bound with vegetation.

22nd October. Considerably straighter than hitherto; in part very broad and with extensive alluvial deposits. Forest and sand alternate; 15 km. to the sandy desert; the forest-belt apparently increases in breadth. In this locality the surplus overflow from the irrigation canal re-enters the river in autumn, occasioning a slight rise, which perceptibly counteracts the tendency to a general fall that the river at that season exhibits.

23rd October. Not particularly winding; extensive alluvial deposits. At Kum-küjük the rest of the Kaschgar-darja water enters the Jarkent-darja; probably this is the most important mouth; it is double, and at that season was dry. But notwithstanding that its two headwaters, the Kisil-su and the Ges-darja, both swell so much in summer as to be with difficulty fordable, the amount of water which the main stream, the Kaschgar-darja, contributes to the Jarkent-darja is but small. Indeed the Kisil-su exhibits a very distinct falling off even by the time it has reached the city of Kaschgar, and the Ges-darja, although an immense flood during its confined passage through the mountains, spreads out, after emerging upon the lowlands, into several shallow arms, which of course act as a severe drain upon it. Add to this the cultivation around Kaschgar, and below that town several marshes beside the river. Maral-baschi, although situated on the Kaschgar-darja, derives its irrigation water, as we have seen, from the Jarkent-darja. Fixed settlements at Matan.

25th October. Not particularly winding; extensive alluvial deposits; several boldschemals; small fluviatile dunes have in several places been formed on the alluvial peninsulas; distance to the sandy desert 40 km. Steppe and bushes, though but little forest.

26th October. The channel rather winding and well supplied with alluvial deposits; steppe predominates; poplar forest at the inner angles of the bends. Yet another branch enters from the Kaschgar-darja; though it contained nothing except stagnant pools. Thus the Kaschgar-darja joins the main stream in different places; that is to say, unlike the Ak-su-darja, it forms a delta, though its arms are not, it is true, very permanent. On the right an old bed of the Jarkent-darja. Wheat is cultivated at Jigde-kotan and Jesi-köl.

27th October. Very winding; a large boldschemal; depth amounting to 6 m. and more; current very sluggish; thin toghrak forest, elsewhere tamarisks and kamisch; terraced banks $3\frac{1}{2}$ m. high. Wheat grown in two or three places.

Herewith we leave the Jarkent-darja behind us, the journey down it having shown clearly that it dwindles as it approaches the confluence of the Ak-su-darja. As compared with this latter, the Jarkent-darja is narrow, deep, winding, and sluggish. Its banks are generally planted with poplar woods. The confluence presents an extensive view across a very flat, broad expanse of alluvium. While the Jarkent-darja brings down in its flood-season but little solid material, the Ak-su-darja still continues to deposit sediment as late as the end of October. During its high-water period this last rolls down immense quantities of mud and sand, which one would expect gradually to raise or else choke up its bed, to the extent of causing serious catastrophes. But as a matter of fact the noteworthy erosive activity which the river develops effects an equilibrium, which is the expression of the component of its erosive and its sedimenting capacities. And from this spot vast quantities of solid material are transported farther down the river.

29th October. The river, henceforward to be called the Tarim, although it does indeed wind, is nevertheless a good deal straighter than the lower Jarkent-darja. It is broad, powerful, shallow; the terraced banks lower than those of the Jarkent-darja. Steppe and bushes next the edge of the river, the fine toghrak forest being some distance back. There are a few settled places, some with, others without, wheat cultivation. Not far from the left bank the sandy belt of Kisil-kum.

30th October. The river especially straight; at this season of the year less than half the river-bed is filled with water. Here it is joined from the south by the broad, flat bed of the Chotan-darja, filled with alluvia. On the northern bank, in the line of its continuation, there is an old river-bed known as Kara-kertschin.

31st October. Ditto — ditto. Below the confluence of the Chotan-darja the bed of the Tarim is broader, and contains more alluvia than above that point. From Modsche-toghrak it is reckoned to be 18 km. to the Kisil-kum in the north-west and 36 km. to the great sandy desert in the south-east. The forest beside the lower Chotan-darja is in places fairly thick, as it is indeed throughout the entire course of the river.

1st November. The river remarkably straight; the last half of the day rather narrow, with a swift current, which in two or three places forms rapids. On the left bank is the sandy belt of Ala-kum, not very far distant; probably it is connected with the Kisil-kum. At Koghunluk on the right bank thick and magnificent forest covers a considerable area. Lower down on the same side is a dry watercourse called Lajlik-darjasi, possibly the beginning of the Atschik-darja that I crossed between the Kerija-darja and the Tarim.

2nd November. River very straight, except for one loop below Läschlik. At this point the Kara-kertschin reenters the Tarim; but on the other hand the Atschik-darja breaks away. This last must not be confounded with the large old bed on the south of the Tarim. Another old river-bed is passed on the left at Topa-kaschte, and lower down a Kona-darja, which the Tarim abandoned three years before my visit. In the newly formed channel, a deep, narrow trench between lofty terraced banks, the velocity amounted to as much as 2.05 m. in the second. Along this stretch erosion is wonderfully active, the river being very energetic in carving out its new bed. The big forest follows of course the Kona-darja, the margins of the Jangi-darja being relatively barren; such vegetation as there is consists for the most part of tamarisks. As a general rule the breadth of the belt of forest and vegetation varies in direct proportion to the changeability of the river-bed. The more the river changes its bed the wider the area that is moistened with its water, and if only the river shifts its position with sufficient frequency, the vegetation will not die out during the intervening periods of drought. The great sandy desert is estimated to be 40 km. from the masar of Ala Kunglek Busrugvar. The Kisil-kum runs behind the old river-beds on the left bank.

3rd November. The river in part very winding, in part straight. Where it is straight, the bed is narrow and the current swift. Poplar forest is abundant. Sheep-breeding is highly cultivated throughout all this region. Here too the river is considered to rise a little just before it freezes. The sandy belt of the Kisil-kum is said on this meridian to be 6 to 7 km. broad; this is evidently the narrow strip of sandy desert that lies between the Ak-su-Kutschar road on the north and the Tarim on the south, although a good deal nearer to the former than to the latter. On the east this strip of desert would appear to be bordered by the Mus-art-darja or Schah-jar-darja. On the right bank lies the belt of sand called Ak-jantak-kum: it appears to be distinct from the great sandy desert, which only begins on the south side of the old bed, the Atschik-darja, three days' journey away.

4th November. The stream very winding, for it flings itself backwards and forwards from one terraced bank to the other, flowing over the alluvial deposits of the high-water channel. Here again the river flows in a new bed. The old bed, which the forest accompanies, lies to the left, and is called the Kök-tschol-darjasi; while the new bed is destitute of forest, the sandy soil beside it producing only steppe. It is moreover deep and narrow, and had a velocity of 1.45 m. in the second.

5th November. The river not particularly winding; the bed narrow and the current swift. Forest appears again below the junction of the Kök-tschol-darjasi; apart from that the toghraks stand in separate groups. Dunes, bound together by vegetation, are abundant.

6th November. The river not particularly sinuous. On both sides several branches go off, though they only carry water during the high-flood period. At Kum-aral and Dung-kotan dunes overgrown with vegetation. Forest abundant.

7th November. The stream tolerably straight. Down as far as Tschong-aral thick and plenteous forest clothes the banks close to the river; but after that they recede from it, the country becoming quite open. Boldschemals, jarsiks, and high-water branches numerous. On the left the river is again joined by the old bed of the Atschik-darja. On the same side it is entered also by the Jilgha, which issues out of the Schah-jar-darja. At Gädschir there are dunes bearing tamarisks. Owing to the vicinity of Schah-jar the country is more inhabited. Several roads and paths. Canoes now began to be numerous.

10th November. The river here makes wide sweeping curves, and has sometimes a narrow bed, sometimes very extensive alluvial deposits. Tamarisk and kamisch steppe predominates. The great forest is a long way from the river. Sandy ground and dunes overgrown with vegetation are frequent. The eroded and terraced banks are at the most 1 m. high, and very often there are none at all. Every now and again there are high-water arms still filled with water. Here is a boldschemal of an exceptionally large size, in fact it is more like a marginal lake.

11th November. The course moderately winding, with an abundance of alluvial deposits; the bed tolerably broad and shallow, and deep at the bends; several boldschemals. Underwoods and steppe. The river is generally called here the Ögen. It is estimated to be two days to the big sandy desert.

12th November. Very winding; thick magnificent forest on both banks. On the south there are considered to be three old river-beds, namely the Kuruk-darja, the Arka-darja, and the Atschik-darja. Their several positions can only be estimated approximately, because the natives seldom visit that region.

13th November. The river tolerably winding; no boldschemals visible. Next the river is kamisch steppe; some distance away thick woods. At a northern bend the Intschkä-darja enters.

14th November. Not particularly sinuous. Here also the natives are acquainted with three old dry river-beds to the south, all embedded in sand. No boldschemals visible; thick woods.

15th November. The river rather winding; a moderate amount of alluvia; a couple of boldschemals; forest sporadic; kamisch and tamarisk steppe predominates. At Kudsche-käldi sand-dunes with tamarisks 4 m. high. Here the big forest appeared to accompany the old river-beds to the south.

16th November. The river rather less sinuous than hitherto, and deep and narrow, and the current sluggish; alluvial deposits less extensive. A high-water channel south of the river. Forest sporadic, otherwise mostly tamarisk steppe. The big forest beside an old bed to the north. Here it was only half a day's journey to the great desert, known locally as Ak-kum.

17th November. Rather big windings, narrow bed, scanty alluvial deposits; a couple of boldschemals; high-water arms connecting the river both ways with the marginal lake of Tschark-asti-köl on the north. Another high-water arm, that does not rejoin the river, and in autumn contains detached pools of water, is known as the Hasanak-darja The old bed of the Kuruk-darja is reported to lie embedded amongst barren sand. Generally speaking, the great sandy desert approaches here nearer than it has done hitherto. Although forest does occur, it is steppe that predominates.

18th November. Only small insignificant bends. The river narrow, sometimes not more than 20 m. across; the depth approaching to 7 m., the terraced banks 2 m. high; scarce any alluvium; thick kamisch steppe on the banks. It is characteristic of this part of the river that it gives off several branches on both sides during the high-water period. The stream is undecided, and shows a tendency to form an inland delta. During the autumn these branches are for the most part dry and the river then resumes its regular appearance, all the water flowing in one and the same bed. Owing to the lateral spread of the water and the low-lying character of the country, there are seven marginal lakes, all bearing names, though possibly there are several others that possess no names. Taken all together they resemble a large marsh or overflow area. On the right bank is the dune of Koral-dung, 10 m. high and bearing vegetation. Around the Ak-kumning-jughan-köl there is a wide expanse of sand. This lake is connected by canals with those alluded to above.

19th November. The river continues to be narrow, and without alluvial deposits, though with numerous marginal lakes, and in fact it may be said generally, that these characteristics become more pronounced in proportion as the country grows flatter towards Lop. The belt of forest very narrow and often interrupted; on both banks a preponderance of sandy ground. The various stretches of dunes bear the names of Peghan-kum, Bel-kum, etc. In two or three places wheat is grown.

20th November. Marginal lakes, side-branches, belts of sand, steppe predominating, as along the last stretch.

21st November. The river-bed recently formed, and consequently straight, narrow, and entirely devoid of alluvium; poplars sporadic; reeds on the actual margins of the river-bed. The transition to the desert, to which we were here close, is very abrupt. The big forest adheres to the old river-bed that we left on the north. The new bed follows in part the marginal lakes of the old bed, and consequently all these have now become filled. On the south a couple of side-branches. The river flows here towards the south-east. The desert on the south is called Tschong-ak-kum. In this region the river is known as the Jumalak-darja. In places there are rapids.

22nd November. Here the river, which follows a moderately winding channel with slight bends, and with side branches and marginal lakes on both banks, cuts its way through a belt of perfectly barren sand, with dunes 10 to 15 m. high, and almost entirely sterile, except for an occasional young poplar and a thin sprinkling of tamarisks and scrub. Close to the edges of the river narrow belts of kamisch with a good many gaps. The branches mentioned in this and the immediately preceding sections as being situated close to the south side of the river, and of which the largest is known as the Kara-akin, may possibly be regarded as evidence of a tendency on its part to flit over into the new bed. On the whole, the river appears to manifest a predilection for shifting its bed towards the right, i. e. the south, though probably there is in this direction a limit which it cannot transcend, and after that the changes of bed will by preference take place towards the north. Thus the river-bed oscillates periodically between a northern limit and a southern limit, precisely in the same way as the terminal lake does.

23rd November. The river moderately winding, the bed still narrow and with very little alluvium. The belts of sand recede and the forest increases in area; marginal lakes and side-branches few in number. On the left bank the little detached patch of sand known as Jar-jeghan-ak-kum.

24th November. The river zigzags backwards and forwards between the sand on the north and the sand on the south, with plenteous forest on both sides; the tips of the windings just touch the sand.

25th November. Along this stretch too the belts of sand lie close to the river and are touched by its elbows on both sides. On the north lies the dune region of Jar-kum. Forest abundant. One day's journey to the south is the dry river-bed of the Opghan-darja, running along the edge of the great sandy desert. Taking into account the river all the way down from Lajlik, it may be said to be generally true, that the farther it travels east, that is to say the nearer it approaches its terminus, the more restless does it grow, and the more frequently does it alter its bed. The boundaries between which this holds good are on the one side those parts of the river-system which belong to the mountains, and in which the glens are fixed unchangeably once for all, and on the other side the lowest parts of its course, where it is incessantly changing its bed.

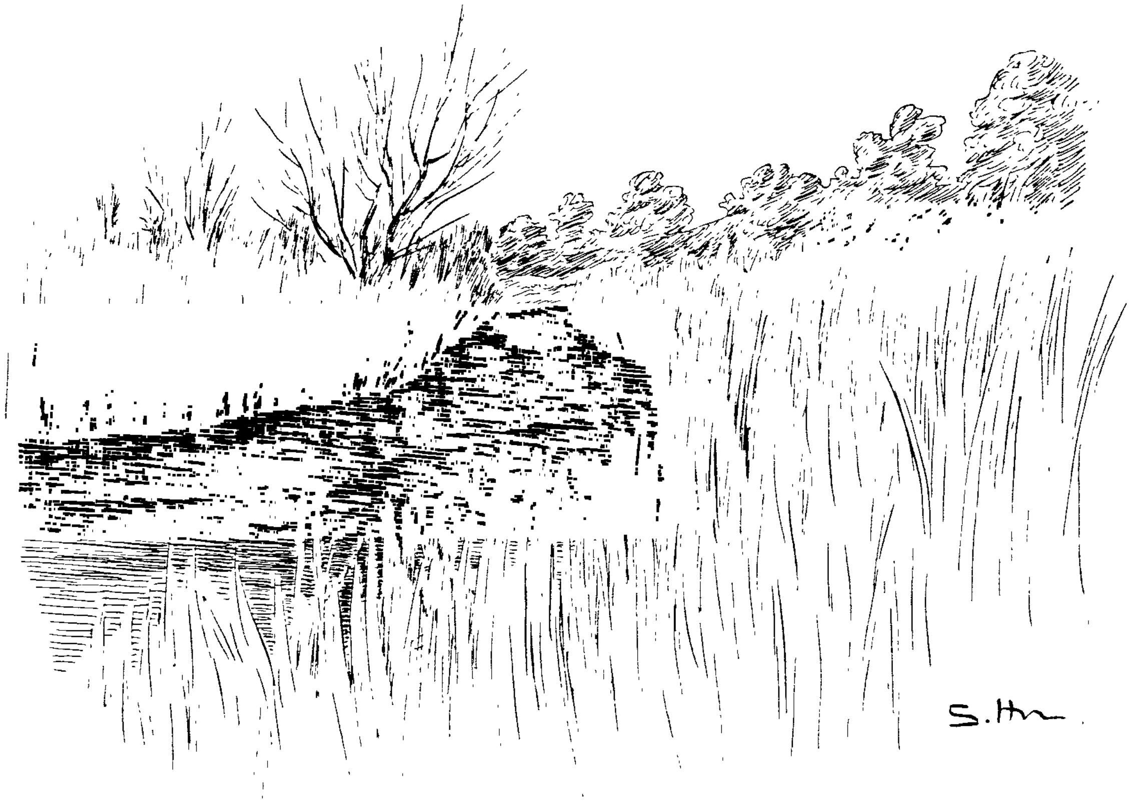


Fig. 241. A VIEW OF THE UGEN-DARJA IN THE NEIGHBOURHOOD OF DUNG-SATMA.

26th November. On the right bank lies the Tokus-kum, a belt of exceptionally high and well-developed dunes; on the north of the river too there is another belt of sand.

27th November. Moderately winding, narrow; alluvial deposits excessively small; forest general; on the south the high barren sand begins immediately behind the belt of vegetation. The Opghan-darja joins the existing bed.

28th November. River serpentines a good deal; the bed rather wider and with rather more alluvium. Marginal lakes very numerous; forest good; to the north-west a belt of high dunes. On the right bank a strip of low dunes, bound with vegetation and known as Töttöru-jaghatsch. The farther the river advances, the more the sand predominates and the higher grow the dunes. In this and the immediately following stretches the river flows towards the north-east.

29th November. Bends pretty large; numerous small marginal lakes. On the right the high sand approaches quite close, e. g. Ansasch-kum. Forest general. From the north enters the Kurugen-ugen. Steppe very common.

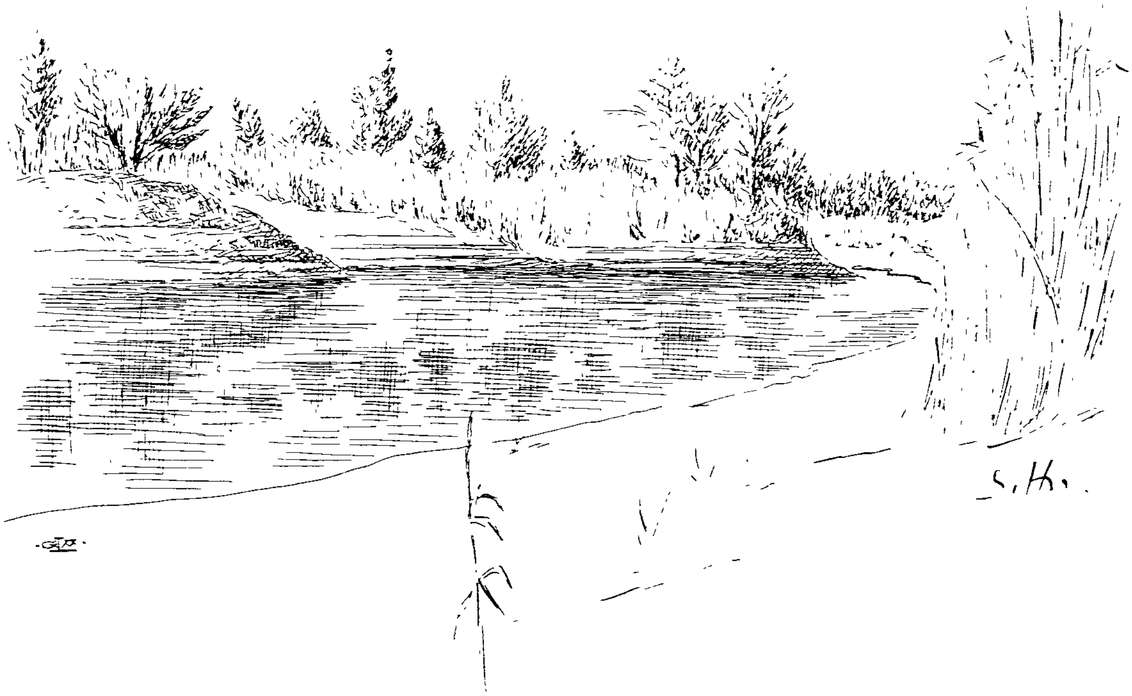


Fig. 242. TSCHA-JAN OR INTSCHKA-DARJA AT TSCHONG-TOKAJ.

30th November. The stream relatively straight, traversing in part luxuriant forest, in part steppe. The bed pretty broad. It is very seldom that the river comes into contact with the high sand, which on its right bank reaches an altitude of 60 to 90 m.

1st December. River broad and moderately winding, and touches the sand at two or three points on both sides. No signs of boldschemals or side-branches; but there are single small marginal lakes. Forest good. On the south-east the sand is high, but not continuous; that on the north-west lower. The belt of vegetation between them is about two km. broad. The sheep industry, which had been decreasing all the way down from Schah-jar, appears to be entirely absent here, at all events at this season of the year.

2nd December. River moderately winding and pretty broad. The sand on the south-east thus far high and well-developed, whilst that on the north of the river has thinned away until it has almost come to an end. Between the Tarim and the Ugen-darja the forest is reported to be continuous.

3rd December. The river tolerably winding and broad, with low terraced banks. On the north forest, on the south high sand quite close to the river, but with dense reed-brakes between the two. From this district the people call themselves Lopliks. In this region the high flood is considered to pass by in the end of September and the beginning of October. In the mountains the high-flood season occurs at the beginning of summer; but the farther down the river one goes the later is the date of its arrival and the more are its effects equalised. In a similar way the quantity of sand in its bed increases with the distance from the source, because the belts of sand, especially the great desert on the south, approach nearer to the river and are more vigorously attacked by it. The sand and silt which are in consequence of this deposited in its bed constitute one of the principal causes of the river's tendency to shift its position.

4th December. The stream winds but little. The bed broad, for the most part filled with water, the alluvial deposits being small. The velocity considerable. The forest comes to an end a little above Karaul. A patch of sand-dunes situated amongst sparse forest is known as Aral-kum.

6th December. Here the river is unusually straight, there being only a couple of accentuated bends at Karaul. There too the river changes its direction from east to south-east. The velocity is great, the bed in places narrow; scarce any alluvial deposits; the terraced banks only ½ m. high. No forest at all, only kamisch and grassy steppes. On the left bank low dunes with tamarisk-mounds. On the right high sand, but some distance away.

7th December. A strong current, forming small rapids as in the immediately preceding stretch. The channel winds but little; what bends there are show a tendency to penetrate into the high sand, which now either directly overhangs the river or is merely separated from it by a narrow belt of steppe. The elbows pointing south are shallow, those pointing north deep, so deep that an 8.6 m. long punting-pole failed to reach the bottom, indeed it was quite *unable* to reach it because of the strength of the current. In the south-going bends the river is broad, in the north-going bends narrow, sometimes little more than 30 m. broad.

# CHAPTER XXXVIII.

## HIGH-WATER PERIODS. — THE TARIM FROM KARAUL TO KARA-KOSCHUN.

The river begins to freeze right across from bank to bank about the beginning of December, although several weeks before that ice forms in the quiet corners and on the shallow marginal lagoons. During the course of the winter the ice increases in thickness, until under the severe continental cold that prevails in those regions it attains considerable dimensions. This ice melts in the spring after being congealed for three months, and when it melts it sets up the *mus-suji*, or »water from the melting of the ice», a spring flood, which in magnitude and volume falls but little short of the high water that comes down in the autumn. A comparison of these two flood periods gives this rule, that while the high-water proper is the bigger higher up nearer to the sources of the river, the spring flood (*mus-suji*) grows more powerful in proportion as the stream approaches its terminus, though it is only exceptionally, and in virtue of extraordinarily favourable conditions of weather, that it surpasses the autumn flood. If we consider for a moment one of the remotest feeders of the river, say a tiny affluent of the upper Jarkent-darja or the Raskan-darja, the volume of its thaw-flood from the melting of the ice is not great, partly because the thaw is only able to give rise to an inconsiderable and transient augmentation of the volume and partly because, when the ice forms in autumn, the stream has already shrunk to such an extent that but little water remains in its bed. Further, it may be observed, that in those lofty regions the mus-suji or thaw-flood coincides in point of time almost exactly with the spring flood proper, that is the flood which arises in consequence of the mountain snow-fields and glaciers beginning to melt in their turn. In some localities, especially in the deep shady glens, this last-mentioned flood may even arrive before the mus-suji starts. But even within the mountains, the two high-water periods begin to be distinguished with increasingly greater distinctness, and as a rule the rise of volume which is occasioned by the melting of the fluvial ice issues from the mountains considerably earlier than the spring flood proper; while in the highest regions the mus-suji betrays its presence rather as a fortuitous fluctuation in the oscillations of the spring flood, a fluctuation which is however quite small in comparison with the fluctuation that occurs every now and again after a few days of warm bright weather, which enhances the rate of thawing on the snowfields, so that the mus-suji upon emerging from the mountains bears the distinct characteristics of a special and independent high-water flood. When the Jarkent-darja issues upon the lowlands the mus-suji, as compared with the volume of the high flood proper, is in point of quantity inconsiderable. In the course of a few days the mus-suji has all gone past; but the true high flood continues to flow on all the summer, so that even in the middle of September, it still amounts to a pretty respectable volume, say on an estimate 150 cub. m. in the second; though this, by the time the river gets down to Lajlik, has decreased to 100 cub. m. in consequence of the drain of the irrigation canals of Jarkent, superadded to the loss experienced through natural causes.

I will here add the observations I made, and the information I received, as to the volume of the river when I crossed over it at Jarkent on 23rd December 1895. It was then divided into three arms. On the day in question the first of these contained nothing more than a sheet of ice, no running water; in other words it was frozen to the bottom. Between this first arm and the second was a broad saj, covered with gravel and rubble stones, forming a flat expanse in the middle of the river-bed which is only under water at the high-water period. The second arm, the middle one of the three, which at that time was the principal artery of the stream, was for so late a season exceptionally full of water, so that travellers and camels were only able to get across it with the help of the ferry-boats. At that place too the Jarkent-darja has two crossings. The more southerly one, which is the one I am now speaking about, can only be used during the high-water period; in the summer the velocity is too strong to admit of the ferry-boats being employed. It is then usual to have recourse to a more northerly crossing, although it involves a considerable detour; but there the current flows less violently and ferry-boats can be used. In this principal channel the main body of the water flowed, on 23rd Dec. 1895, close to the left bank, where the maximum velocity amounted to 2.31 m. in the second and the maximum depth was 2.80 m., though generally speaking the depth was 1 to 2 m. Although the erosion in that locality is incomparably more powerful than in the lower part of the river, above the confluence of the Ak-su-darja, there are nowhere any places so deep as we find there. Every year however the high-flood rolls down as far as Jarkent immense quantities of rubble stones and river-gravel; though probably only to 10 km. or so north of the point in question. At the place where the summer crossing is situated there is but little gravel, and at Lajlik there is none. The breadth amounted to 33 m.; the temperature of the water was +0.3°, while the temperature of the air at noon was +0.7°; the transparency was 22 cm. The volume amounted to 88.6 cub.m. in the second. Add to this the volume of the third arm, on the east, which was 4 cub.m., and we obtain for the 23rd Dec. a total volume of 92.6 cub.m. in the second. In other words, the river had decreased by 60 cub.m. since the end of September in the same year, the last occasion on which I effected a measurement. This result, when compared with the observations I made in 1899, is quite unexpected. Let us consider first the season of the year. As we may assume that the several periods are repeated annually, we have for the 16th September (1899) at Lajlik 98 cub.m., and for 23rd December (1895) at Jarkent 92 cub.m. The latter measurement was taken 18 km. above the city of Jarkent, and the distance between it and Lajlik is 100 km. Thus the two points lie a considerable distance apart, and it may be assumed that along that stretch the river loses a good deal of its volume through evaporation, absorption into the ground, and freezing. At Lajlik on 23rd December the volume ought to be about 70 cub.m. If however it already amounts at that place to 98 cub.m. on the 16th September, we have an unexpectedly small drop in the three months. But then there is an artificial factor of great importance which comes into play. On the 16th September the numerous irrigation canals throughout the extensive district of Jarkent, several of which carry each a very respectable volume, are all open and draw off from the mother river a very appreciable percentage of its water. On the 23rd December the position is in this respect very different. In most of the canals the velocity is less than in the river, and consequently they freeze sooner than it does. When I traversed the district on the date mentioned nearly all the canals were frozen to the bottom, and consequently at that season were depriving the river of none of its water. Hence the entire volume that the river then possessed flowed on without diminution past the point where I crossed over it, that is immediately north of Posgham, for all the canals break away above that point. Were there no canals, the volume at Lajlik on 16th September would be incomparably greater than 98 cub.m.

From the end of December the river drops daily (at Jarkent) all through January and February, and for about 25 days in the former of these two months it is frozen, and the ice is frequently so strong that caravans and *arabas*, or »native carts«, are able to cross over on the ice. But as the ferry-men depend for their livelihood upon putting travellers across the river, it is to their interest that the ice should break up as soon as possible, and accordingly they proceed to break it up at the ferry sooner than is necessary. In the end of February the river drops at Jarkent to its lowest ebb, partly because of the severe cold which reigns in the mountainous regions and partly because that is the season when the irrigation canals are all opened and put in order so as to be ready to water the spring-sown seed. In fact the Jarkent-darja is said to be then in places so shallow that it is possible to ford it on horseback. But in March the melting of the river-ice gives occasion to an early spring-flood, the mus-suji. In the beginning of that month in the year 1896 the river at Mejnet was so full that it was not possible to cross it anywhere without a ferry-boat; at intervals sheets of ice came floating down, these being the last remnants of the great ice-field that gets set adrift and gives rise to the mus-suji. I was told, that when the spring-flood proper arrives, the river swells out there to $1^1/_2$ km. in breadth. And so swift is the current that for the space of twenty days in the end of June and beginning of July nobody ventures to cross over the onrolling masses of muddy water even by ferry-boat; thus for that period communication between the two banks is quite severed. At the same time the road between Mejnet and Ala-ajghir is rendered impassible by reason of extensive overflows of the river. Such areas of inundation occur, as we have seen, all down the Tarim right away to its termination, being occasioned by the extreme flatness of the country, the frequently low terraced banks, in conjunction with the immense masses of water that roll down the river; and through these inundations probably quite as much water is lost as disappears through the instrumentality of the permanent or newly formed marginal lakes. Between Lajlik and Mejnet the level of the high water is said to rise fully 2 m. above the level at the beginning of March.

On the 8th March the water had at Lajlik a temperature of 8.3° and all the drift-ice had disappeared; the transparency amounted to 4.9 cm. At its narrowest part, just where the ferry-boat between Lajlik and Merket maintains communication between the two banks, the breadth amounted to 61.4 m. The river-bed presents in its formation at that place a good deal of regularity. The greatest depth was sounded under the right bank, where the volume also was the greatest, precisely as was the case a little lower down where we made our camp in 1899. The maximum depth amounted to 1.90 and the mean depth to 1.75 m.; while the mean velocity worked out at 80.6 cm. and the volume at 86.6 cub. m. per second. Consequently the river had at Lajlik on the 8th March about the same volume that it had at Jarkent on 23rd December. For this there is one very simple explanation: it lies in the word *mus-suji*. After the river has dropped to its lowest ebb in January and February, it begins to rise in consequence of the melting of the ice, and by 8th March the rise has already passed its maximum. After that date the river at Lajlik continues to fall, until in the latter half of the spring it gets as low as it is in the end of February. Thus it was that on 30th May I found in the Jarkent-darja immediately above its confluence with the Ak-su-darja a volume of not more than 7.5 cub.m.; but to this result the serious drain made by the large irrigation canal which goes to Maral-baschi must be regarded as a contributory. One or two weeks later the river rapidly rises at that point, until it swells out to gigantic dimensions, fully equal to those it assumes at the season of the high flood proper, which arrives at midsummer. There is therefore in the lower Jarkent-darja an interval of three months between the arrival of the mus-suji and the arrival of the high-flood proper.

And the same interval parts the two in the Ak-su-darja; though in consequence of that river's shorter course, both floods arrive at an earlier date. On the 31st May its Kona-darja carried 7.6 cub.m. and the main stream on 2nd June a volume of 69.3 cub.m., or a total of 77 cub.m. But by 8th June the united volume of the Ak-su-darja had swollen to no less than 475 cub.m. in the second, and there was every probability that the river would rise higher still. And just as this flood reached the confluence a month earlier than that of the Jarkent-darja, so we may also assume that the mus-suji of the former would also reach the same point a month sooner than the mus-suji of the latter. At any rate the difference in time is at least two weeks (see vol. I., p. 80).

We have found therefore that, while the two high-water periods occur almost simultaneously in the highland regions, at the confluence of the Ak-su-darja and the Jarkent-darja they are separated by an interval of three months. And when we get down towards the end of the river, for instance at Abdal, the difference amounts to no less than seven months; though here we have also the great peculiarity, that the high water which is caused by the thaw-flood is virtually as powerful as the flood of the high-water season proper. The former occurs throughout the whole of the course of the Tarim at approximately the same time; and this is of course only what might be expected, seeing that the effects of the spring warmth are not only simultaneous throughout the region through which the river flows, but are also uniformly distributed. There is however a slight retardation in the lower course. We have seen that at Lajlik the mus-suji goes past on the 8th March, at Jangi-köl on the 12—14th March, at Abdal in the end of March. Theoretically this spring flood ought be cumulative in its mass in the lower part of the river, that is to say in each successive locality it ought to have a greater volume than in the locality immediately above. But the fact is, that vast quantities of water go to fill the marginal lakes, which have shrunk owing to the evaporation of the summer and autumn before, so that there is in reality no very appreciable cumulative process. The length of the mus-suji period ought however to increase as the flood travels downstream. If we take it, that the thaw-flood flows past Lajlik for a space of 20 days, then the mus-suji must last longer at Jangi-köl, because all the flood-water that is set free in the sections higher up must go past Jangi-köl. All the same it is pretty certain, that the bulk of the water which forms the mus-suji at Jangi-köl is derived from localities immediately above that point, and only in diminishing quantities from the districts higher up the river. Hence the mus-suji of Lajlik is hardly likely to make itself perceptible so far down as Jangi-köl; but on the other hand the accumulated effect of all the flood-sections which lie between Lajlik and Jangi-köl do eventually make themselves apparent in that they give rise to an augmentation of the mus-suji at the latter place.

The causes why the high-flood proper is so greatly retarded are in part the greatness of the distance, in part the presence of the marginal lakes, which suffer such heavy losses in the summer through evaporation. Although this flood originates in the spring and early summer it does not reach the terminal lake before the late autumn, in October. And how greatly does it dwindle on the way! Although the Ak-su-darja alone has a volume of 475 cub.m. in the beginning of June, the united Tarim at Abdal is hardly able to muster all told a volume of 170 cub.m. The river is like a retreating army, only a very small fraction of it succeeds in reaching its goal, while the main body perishes on the way. In the Tschertschen-darja the circumstances are more favourable, for in consequence of its much shorter course the interval between the two high-water periods is very much less; the high flood proper reaches the Kara-buran during the first half of the summer.

Let us now, after this digression, return to our running résumé of the river's course. From Karaul downwards the river assumes an extremely peculiar and unexpected character. From that point we may legitimately speak of a secular delta or a triangular *rayon* with acute angles, over which the Tarim and its branches have ranged backwards and forwards from north to south and from south to north for centuries, and even thousands of years; a deltaic region, the south-west limit of which has not yet been attained, as is evident from the character of the sandy desert in that quarter. Owing to the alluvial deposits of the river and its levelling activity, this region is so flat that all the presuppositions and pre-existent conditions point to the probability of fresh changes taking place in its bed. From Karaul to Arghan the Tarim flows immediately along the north-east front of the high sandy desert, forming elongated marginal lakes in the hollows between the dune-accumulations, a state of things which did not exist, at any rate not to the same extent as now, when the Tarim flowed along the northern limit-line of its delta.

During the 19th May therefore the river was accompanied, as it was during the immediately preceding stages, by a string of marginal lakes on its right bank. The course was especially straight, the bed broad, the alluvial deposits not particularly extensive, and such as there were consisted of »sedimented» sand. The country was open, the surface in part bare, in part overgrown with kamisch and grass. The few poplars that occurred were quite young. Along that stretch there are several old river-beds on the left side of the stream, each of which has in turn served to carry the river.

The same observations hold good for the section traversed on the 21st May, except that the river was a little more winding.

22nd May. Still the same observations apply.

23rd May. The river is frequently inclosed between high terraced and bare banks. Below Bulung-su the delta grows still more intricate, the old beds increasing in number. Along certain stretches the river inclines to the left as well as to the right. At Eski-tarim the forest is both thick and old.

24th May. The river is here perfectly new, and resembles an inundation which is gradually eroding a definite channel for itself. Great velocity, amounting to 1.4 m. in the second. It now quits the bed in which it has flowed during the last stadium of its history, and is forming a great number of flat, reed-grown lakes. This description applies also to the next day's section. The old river-bed is thus in this region situated between on the one hand these new lakes, in which the river now loses its identity, and on the other the older lakes wedged in between the dune-accumulations on the right bank. These new lakes are in general very shallow, though in one of them I obtained a sounding of 14 m., the greatest depth in all the Lop country. Generally, the river in this region is vacillating and hesitating, as though it had not yet decided where it will make its permanent bed. During the last few days it had exhibited a strong inclination to press towards the right; here on the contrary, after having for a time flowed to the south-west, it manifests a tendency to return towards the east. Thus it leaves, as I have said, an old bed along the foot of the high sand. And not only does the present river form a series of lakes, it also sends off to the left, that is to the east, several branches, which for the most part join the old river-bed at Arghan, after having emptied themselves into the Kuntschekisch-tarim. The most important of these branches is the Laschin-darja, which will probably become the principal bed of the Tarim when the long chain of lakes have become for the most part filled with mud and sand.

After traversing the chain of characteristic kamisch lakes, the remainder of the lake water re-enters the Tarim, which by that has dwindled to quite an insignificant stream, for it has given up the greater part of its volume to the Laschin-darja.

28th May. The course winding; the velocity slight; the depth approaching 5 m.; the banks relatively well clothed with poplar forest. The bed bore evidences of having been traversed by a large stream not very long before our visit.

29th May. The Adoke-kok-alasi issues from the Laschin-darja and rejoins the Tarim. The surface of the ground is sandy. This branch also carried at one time the whole of the Tarim.

30th May. The course tolerably winding: little forest: reeds dense. The river again enters a series of lakes.

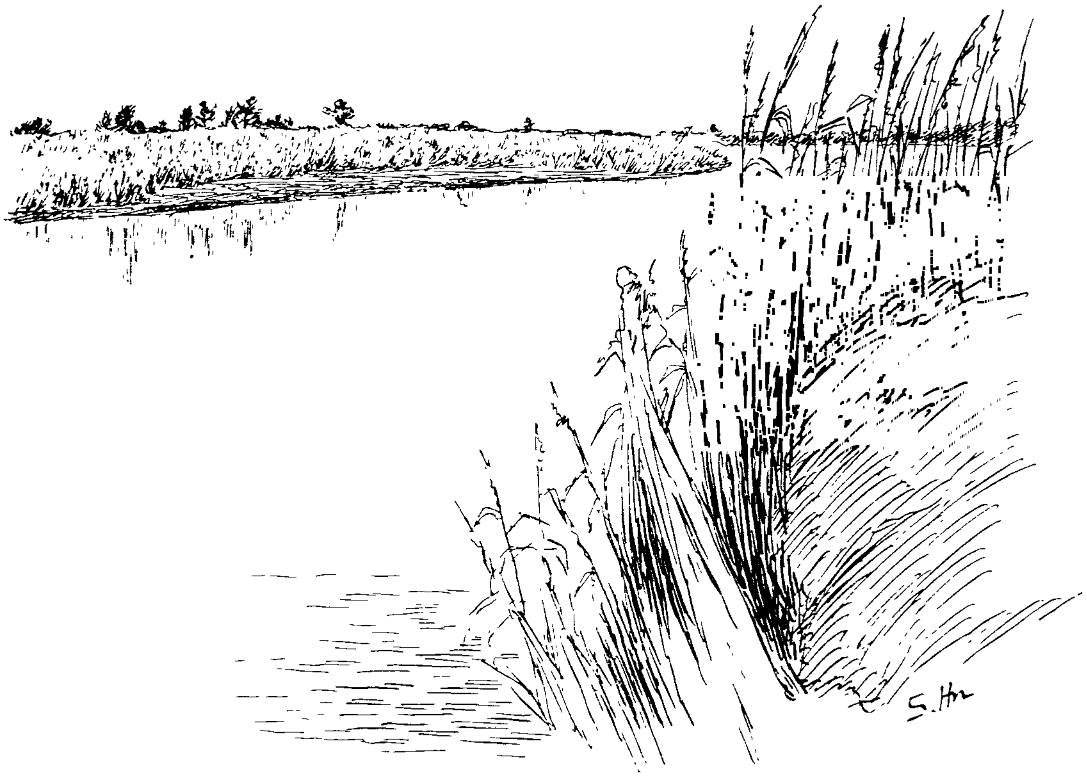


Fig. 243. THE KUNTSCHEKISCH-TARIM AT KIRTSCHIN-KOTAN.

31st May. After traversing this fresh chain of lakes, the water once more re-enters the old bed of the Tarim. From these lakes it issues, as it did from the former series, clear and bright, having dropped in them all the sediment it carried in suspension. At its issue from each chain of lacustrine basins it forms cataracts. The direction of the longer axes of the lakes from north-west to south-east is dictated by the ramparts of the old river-beds, between which the overflows take place. Upon issuing from the lower series of lakes the river is deep, with an exceedingly slow current. Only a few solitary poplars.

1st June. The river describes several small bends, and has a very sluggish flow, for this is now again the old bed which it is about to abandon. The high sand is touched at one point only. On the left the large marginal lake of Putalik-köl. Poplar woods pretty abundant; tamarisks growing amongst dunes held together by vegetation. At Basch-arghan begins the old bed of the Tarim known as the Ettek-tarim; this runs due south until it enters the Kara-buran at the village of Lop. Its bed was definitively abandoned about 35 years ago, but is still quite distinct, although a dune-accumulation in its westward advance is threatening to obliterate it. Below Basch-arghan the river grows very narrow and deep, with high eroded, terraced banks: scarce any alluvial deposits, but with forest.

2nd June. Ditto, ditto. The river swings away towards the north-east, without forming any abrupt bends. Respectable forest on both banks. Some desiccated lakes bear witness to the hydrographical arrangement having formerly been different. The depth approaches to 5 m. The water is especially clear, owing to the slowness of the current. Here then the dying Tarim is digging for itself a deep grave filled with a considerable volume of water, which literally «crawls» along at an exceedingly slow rate.

At Arghan the waters gather from various directions. Both the Tarim and the Kontsche-darja divide above the Tschivilik-köl, and a partial blending of their branches ensues. Not to plunge again into the mass of details recorded in the last chapter of vol. I, I will content myself with observing, that the Kontsche-darja divides into the two main arteries, the Bos-ilek, which goes to the eastern chain of lakes, beginning with the Avullu-köl, and the Kuntschekisch-tarim, which, after picking up the two branches of the Tarim, the Kalmak-ottogho and the Laschin-darja, again divides. But both its eastern arm, which enters first the Tschivilik-köl, and its western arm, the Jätim-tarim, proceed to Arghan. The greater part of the water of the Kuntschekisch-tarim and the Laschin-darja enters the large stream of the Ilek, which is situated between the eastern chain of lakes on the one side and the Tschivilik arms and Arghan on the other. The lowermost lake of the chain sends off a channel to the Ilek, which then forms yet another series of lakes — the Sadak-köl, Nias-köl, and several others. Its last surviving water reunites with the Tarim at Schirge-tschapghan. Hence the contribution which the Kontsche-darja should make to the Tarim is in great part dissipated through the numerous branches and lakes into which it flows. To the upper group of lakes I have applied the general name of Maltak-köl, and the largest stream which issues from it to the Kuntschekisch-tarim is the Turkomakte-kok-alasi. Over these several groups of lakes the Maltak lakes, the Tschivilik-köl, and the Kara-köl lakes (the eastern chain) vast quantities of water evaporate in the arid climate, so that the rivers upon issuing from their respective lake-complexes have been robbed of a very large percentage of their volumes. Were it not for these lakes, and did the Kontsche-darja only proceed in a single continuous and connected channel, instead of being dissipated in the way it is, the river, as I have already said, would be able to reach the Kara-koschun, or in other words would be capable of affording a very respectable addition to the waters of the Tarim.

And the same thing holds good of the Tarim itself. The continual splitting up into branches and the repeated formation of extensive shallow lakes do but enlarge the areas over which evaporation and surface absorption take place. The heaviest drain that is made upon the Tarim anywhere throughout its course begins therefore below Jangi-köl. Here again three different lacustrine groups may be distinguished, one, the Tschivilik-köl, being common to both the Kontsche-darja and the Tarim. The other two groups are the 35 marginal lakes in the sandy desert and the flat kamisch lakes above Arghan. Thus it is also true of the Tarim, that if it possessed one single definite, decided bed, its effectiveness at Kum-tschapghan would be considerable, and its terminal lake, the Kara-koschun, would be much larger than it actually is now. Every year probably a greater quantity of water is lost in the inland delta which stretches from Arghan up to Jangi-köl than in the actual terminal lake itself. And not only is the water in that region dissipated through a vast number of arms, but these arms themselves are excessively unstable, and are incessantly shifting, so that it is only in respect of the broad features that Prschevalskij's first map is like my last. In consequence of these reiterated shiftings the arid surface imbibes enormous quantities of water.

Fig. 244. THE TURKOMAKTE-KOK-ALASI.

It is peculiarly characteristic of the lakes of this region that practically all the lakes are very elongated in shape. Round lakes are exceedingly rare, and what do occur are all small. Both the shape of the lakes and the orientation of their long axes are an expression of the relief of the ground, and this again is an expression of the effects of the wind. Throughout the whole of the Lop country there is not a single lake that stretches east and west. They either extend from north to south, and thus fill existing or former bajir-depressions, or else they extend from south-west to north-east, and thus occupy the gullies that have been directly hollowed out by the wind. The lakes which stretch from north-west to south-east have nothing whatever to do with the wind; they are overflows from the rivers held up between older fluvial ramparts.

One peculiarity which the lower Tarim shares in common with several other flat-land rivers, such as the Hwang-ho and the Po, is its tendency to elevate its banks and form marginal ramparts, where the fluvial mud and dust are arrested by vegetation. These are the outcome of the river's desperate attempts to protect itself against premature extinction. During the high-water period the level of the Tarim lies for great distances rather higher than the level of the adjacent lowlands, a circumstance which greatly enhances the easy formation of marginal lakes.

We have seen that even the Jarkent-darja forms boldschemals not far below Lajlik, indeed one may say shortly after emerging upon the lowlands: that is to say it cuts off and abandons its own »ripe» bends. On the whole this tendency may be said to increase as the river proceeds towards its termination. In the lowermost part of its course these abandoned dead-water loops are extraordinarily numerous; in fact they are so many that it is impossible to calculate their numbers. In a drift down the river such as mine one probably sees only a portion of the existing boldschemals, for the oldest ones are masked by vegetation. In order to obtain a map that should claim to be complete in respect of the boldschemals, marginal lakes, side-channels and river-branches, the character of the banks, the routes, huts, shepherds' encampments, and so forth, it would be necessary, not to drift down the river merely but also to travel along both its right and its left bank, an undertaking which I scarce think any man will willingly submit himself to.

5th June. Although the river shrinks below the kamisch lakes to an inconsiderable and dwindling stream, below Arghan, after receiving the influx of the Tschivilik district, it swells out to more imposing dimensions. The course is not particularly winding. Magnificent forest on the banks, reputed to be about 100 years old. Many boldschemals, frequently in pairs. The river is augmented by the two arms, the Kulatscha and the Almontschuk-kok-ala, coming from the Ilek on the east.

6th June. The river not particularly winding. Magnificent forest, often undermined, at the bends. The terraced banks as much as 4 m. high, and the depth considerable. The river is thus sharply defined, a characteristic common to all the arms of the lower Tarim. We observed a similar conformation, though even more distinctly marked, in the Ugen-darja.

10th June. The river in part perfectly straight, in part forming deep bends; boldschemals and jarsiks numerous. On the banks thick forest or steppe; small strips of sand in places. Here the high desert sand nowhere approaches the right bank; for since the existing bed was formed, the desert sand has been able to advance away from it. At Schirge-tschapghan the river derives an accession of water from the Ilek and the eastern chain of lakes, the lake from which it last issues being the Karaunelik-köl, which plays an important part as a water-distributor. From it the water flows westwards to the Tarim and eastwards to the Tokus-tarim; at the present time the first-named is shrinking, the latter increasing. The Tokus-tarim flows almost parallel to the last section of the Tarim, and like it empties into the Kara-koschun. Indeed it looks as if the Tokus-tarim will in time usurp the place of the Tschong-tarim, and carry the united flood of the entire system, a circumstance that is to some extent connected with the migration of the terminal lake towards the north. In fact at a former stadium in the river's history the Tokus-tarim was the principal channel; on its banks the forest is dead, the living forest of tall trees comes to an end at Schirge-tschapghan.

11th June. The river is in part very winding. The few poplars that occur are quite young.

Fig. 245. THE TARIM AT SCHIRGE-TSCHAPGHAN.

Finally the Tarim, divided into a number of arms, enters a series of extremely shallow lakes belonging to a group to which the common name of Kara-buran may be given. The actual Kara-buran has for the most part disappeared since Prschevalskij's time, or has at all events dwindled to an excessively small basin. The autumn flood does indeed fill it, but in summer it dries up entirely. The river, in its passage across it, has fenced itself in between pier-like ramparts. The exceedingly changeable and restless delta land of the Tschertschen-darja is intimately connected with this lake. The river last-mentioned carried on 21st June a volume of only $3^1{}_2$ cub.m. in the second.

In the last stage, between the Kara-buran lakes and Kum-tschapghan, the bed is deep and narrow, and entirely free from alluvial deposits. Indeed alluvium occurs but seldom below the upper chain of lakes. Its absence furnishes an indirect proof, that the river deposits its sediment in the lakes, and thus is filling up their basins instead of forming sedimentary deposits in the latest stage of its own channel. The terminal delta of the Tarim begins at Abdal. There the river divides into numerous arms, which have greatly increased in both size and number since Prschevalskij's time. They have been caused by the river gradually raising its side-ramparts simultaneously with the filling up of the Kara-koschun, so that its mean level is higher now than it was formerly. In this way both the lake and the river now lie at a higher level than the circumjacent country, which is almost inconceivably flat. Hence a breach at a weak spot in one of these side-ramparts is all that is required to originate a fresh arm. It is to this cause that we must attribute the existence of the great number of shallow lagoons on both sides of this the lowest stage of the river, all having a more or less direct connection with the Kara-koschun. These newly-formed lagoons, together with the desert lakes, which during the last few years have formed to the north of the Kara-koschun, and which in the near future will almost certainly increase in area, represent or correspond to those parts of the Kara-koschun which are no longer able to find room in its basin in consequence of the sedimentation which has taken place in it. If only the Tarim remains constant to its existing bed — i. e. the final stage of it — for a sufficient length of time, it will eventually destroy the whole of the Kara-koschun, after which this lake will then sink to the humbler position of a marginal lagoon. The ramparts and piers which the river is now building in certain parts of the Kara-koschun, especially on the border-line between this lake and the new desert-lakes to the north, prove that it is actually tending in the direction indicated.

What I have said with regard to the orientation of the long axes of the lakes applies also to the rivers. In those sections of its course in which the river flows from north to south, it follows the old bajir depressions, but in its south-west to north-east sections it traverses wind-eroded gullies similar to those of the Desert of Lop. In these latter sections its bed is straighter than in the meridional sections.

This brings to an end this greatly condensed résumé of the Tarim system, except that in a separate chapter I shall have to consider the relative altitudes and the river's relations to the same. It would serve no purpose to enumerate here the names of the various arms of the lower Tarim, for they are all streams of a purely ephemeral character. In the future the hydrographical arrangement will — and of absolute necessity must — be different from what I found it in 1899 and 1900. I have already said, and now repeat again, that it would be very interesting, some ten years hence, to make yet another journey down the Tarim under precisely the same conditions as those under which I carried out this journey, that is to say at the same season of the year, and to construct a map on precisely the same scale. A comparison of the two maps, supposing them drawn with the same degree of accuracy, would allow of far surer and more wide-reaching conclusions being drawn than those which I have been able to deduce. It would also be instructive to journey down the river from the middle of June, when one would be able to witness the effects of the high flood with one's own eyes.

# CHAPTER XXXIX.

## RIVER AND LAKE STATISTICS.

The first part of the present chapter is devoted to certain tables summarising the results of the measurements I made and have detailed in vol. I *passim*.

The following table contains in its third column the extent to which the water was transparent downwards; in the fourth the fall (—) or rise (+) of level at the several points of observation, though I may add, that while the interval observed was generally 13 to 14 hours, namely the period for which we halted during the night, yet in some places it extended over about forty-eight hours; in the fifth column the height of the erosion terrace at the various camps; and in the last column the height of the maximum high-water level above the existing level of the river at the same points. The value of the table is not great, because of the many elements of chance which enter into and influence the results. All the same it does permit of certain deductions being made, which I will proceed to point out. All the values in the table are given in meters. When two values are given for the transparency, one was taken at 7 a. m., the other at 1 p. m. — the former at the camp before we left in the morning, the latter on the journey during the day.

| Point of Observation | Date. | Transparency. | Oscillation of Surface | Height of Erosion Terrace | High-water Level above Present Level |
|---|---|---|---|---|---|
| Lajlik | 16 Sept. | — | — | 2.5 | — |
| Below Lajlik | 17 » | — | — | 3.0 | — |
| » » | 19 » | — | — | 1.5 | — |
| Schäschkak | 20 | — | − 0.010 | — | — |
| » | 21 » | — | + 0.015 | — | — |
| At-pangsa | 22 | — | ± 0.000 | — | — |
| Kötäklik-ajaghi | 24 » | — | + 0.003 | 1.5 | — |
| Below Kötäklik | 25 » | — | — | 2.0 | — |
| Kum-atschal | 27 » | — | − 0.038 | 2.5 | — |
| Läschlik | 28 » | 0.125 | − 0.009 | — | — |
| Jalghus-jigde | 29 | — | − 0.020 | — | — |

| Point of Observation. | Date. | Transparency | Oscillation of Surface. | Height of Erosion Terrace. | High-water Level above Present Level |
|---|---|---|---|---|---|
| Kijik-tele-tschöl | 30 Sept. | 0.135 | − 0.021 | — | — |
| Haradighan-kötäk | 1 Oct. | 0.137 | − 0.017 | 3.0 | — |
| Kuruk-asti | 4 | 0.300 | − 0.039 | — | — |
| Jughan-balik | 5 | 0.240 | − 0.013 | — | — |
| Sorun | 6 | 0.305 | — | — | — |
| » | 7 | 0.345 | − 0.020 | — | — |
|  | 8 | 0.380 | − 0.020 | — | — |
| More | 9 | 0.297 | − 0.020 | — | — |
| Milka | 10 | 0.370 | − 0.017 | — | — |
| Ak-satma | 11 | 0.315 | − 0.012 | — | — |
| Dugha-dschaji | 12 | 0.391 | − 0.012 | 2.08 | — |
| Tugha-pangsa | 13 | 0.383 | − 0.014 | — | — |
| Toghri-kum | 14 | 0.390 | − 0.007 | — | — |
| Jigdelik | 15 | 0.339<br>0.380 | + 0.006 | — | — |
| Islik | 16 | 0.378<br>0.354 | + 0.006 | — | — |
| Kujluschning-baschi | 17 | 0.345 | + 0.005 | — | — |
| Ja-kotan | 18 | 0.240<br>0.200 | ± 0.000 | — | — |
| Atschi-dung | 19 | 0.214 | − 0.006 | — | — |
| Dung-gerem | 20 | 0.268<br>0.170 | − 0.053 | — | — |
| Kalmak-kum | 21 | 0.225 | − 0.001 | — | — |
| Tscholak-dung | 22 | 0.239<br>0.179 | − 0.005 | — | — |
| Usun-jurt | 23 | 0.150<br>0.190 | − 0.007 | — | — |
| Matan | 24–25 | 0.236<br>0.194 | − 0.016 | 2.84 | — |
| Hangetlik | 26 | 0.178<br>0.168 | − 0.007 | 2.73 | — |
| Jesi-köl | 27 | 0.188<br>0.163 | − 0.008 | 2.05 | 1.17 |
| Jarkent-darja | 28 | 0.216 | — | — | — |
| Ak-su-darja | 28 | 0.138 | — | — | — |
| » | 29 | 0.122 | + 0.020 | — | — |
| » | 29 | 0.146 | — | — | — |
| Aral | 30 | 0.132 | + 0.009 | 2.37 | — |
| Kan-begi | 31 | 0.109<br>0.115 | + 0.009 | 1.88 | 1.48 |
| Modsche-toghrak | 1 Nov. | 0.129<br>0.103 | + 0.005 | 3.10 | 1.96 |
| Läschlik | 2 | 0.135<br>0.076 | − 0.034 | 2.50 | 2.01 |

| Point of Observation. | Date | Transparency. | Oscillation of Surface. | Height of Erosion Terrace | High-water Level above Present Level. |
|---|---|---|---|---|---|
| Ala-Kunglek Busrugvar | 3 Nov. | 0.055<br>0.042 | + 0.016 | 4.62 | 1.51 |
| Tälpäk | 4 | 0.056<br>0.059 | + 0.048 | 4.05 | 3.21 |
| Intschkä | 5 | 0.057<br>0.046 | + 0.019 | 5.12 | 2.72 |
| Bostan | 6 | 0.056<br>0.042 | − 0.017 | 2.36 | 1.98 |
| Kara-daschi | 7 | 0.052<br>0.040 | + 0.017 | 3.46 | 2.36 |
| Gädschir, Tarim | 7 | 0.040 | — | 1.50 | — |
| „ , Mus-art-darja | 7 | 0.780 | — | 1.50 | — |
| Teres | 8 | 0.054<br>0.023 | — | — | — |
| „ | 9 | 0.055<br>0.053 | — | — | — |
| „ | 10 | 0.025<br>0.035 | − 0.051 | — | — |
| Arik-aghsi | 11 | 0.048<br>0.040 | − 0.013 | 2.05 | 1.77 |
| Tugha-baschi | 12 | 0.044<br>0.050 | − 0.007 | 3.87 | 2.65 |
| Sor-sure | 13 | 0.034<br>0.059 | ± 0.000 | 2.44 | 1.81 |
| Lanka | 14 | 0.038<br>0.051 | + 0.005 | 3.00 | 2.14 |
| Tupe-teschdi | 15 | 0.059<br>0.059 | − 0.010 | 3.20 | 2.60 |
| Kade-dung | 16 | 0.050<br>0.055 | ± 0.000 | 2.81 | 2.22 |
| Daghi | 17 | 0.036<br>0.069 | ± 0.000 | 2.83 | 2.31 |
| Kitschik-hasanak | 18 | 0.051<br>0.046 | + 0.005 | 4.00 | 3.10 |
| Tschong-aralning-toghraghi | 19 | 0.047<br>0.050 | + 0.035 | 2.50 | 2.50 + ? |
| Kakde | 20 | 0.051<br>0.056 | + 0.028 | 2.41 | 2.41 + ? |
| Kätschik | 21 | 0.059 | + 0.003 | 1.84 | — |
| Kätschkin-aghis | 22 | 0.031<br>0.040 | + 0.008 | 0.60 | — |
| Unnamed Camp | 23 | 0.040<br>0.051 | + 0.002 | 2.60 | 1.50 |
| Tschong-tötturu | 24 | 0.040<br>0.060 | − 0.007 | 2.70 | 2.00 |
| Kargha-jakti | 25 | 0.066<br>0.052 | + 0.007 | 1.65 | 1.65 + ? |

| Point of Observation. | Date. | Transparency. | Oscillation of Surface. | Height of Erosion Terrace | High-water Level above Present Level |
|---|---|---|---|---|---|
| Tokus-kum | 26 Nov. | 0.088<br>0.079 | ± 0.000 | 1.90 | 1.50 |
| Al-katik-tscheke | 27 | 0.073<br>0.069 | + 0.010 | 1.40 | 1.32 |
| Busrugvar | 28 | 0.078<br>0.072 | − 0.018 | 1.38 | 0.98 |
| Kum-tscheke | 29 | 0.072<br>0.069 | ± 0.000 | — | — |
| Kurugen-ugen | 30 | 0.070<br>0.070 | ± 0.000 | — | 1.35 |
| Ait-öttögen | 1 Dec. | 0.070<br>0.068 | ± 0.000 | 1.45 | 1.20 |
| Kischlak-uj | 2 | 0.080<br>0.095 | + 0.003 | 1.42 | 0.94 |
| Ilek | 3 | 0.095<br>0.076 | — | 1.35 | 0.84 |
| Momuni-ottogho | 4 | 0.074<br>0.079 | + 0.011 | 1.92 | 0.65 |
| Karaul, Ugen-darja | 5 » | 0.690 | — | 0.49 | — |
| » » | 6 | 0.570 | — | — | — |
| » , Tarim | 6 | 0.086 | — | — | — |
| Teis-köl | 7 | 0.083<br>0.090 | ± 0.000 | — | — |
| Jangi-köl | 8 | 0.089 | — | — | — |
| » | 15 | 0 190 | − 0.240 | — | — |
| » | 16 | — | + 0.250 | — | — |
| » | 18 » | 0.295 | − 0.280 | — | — |
| » | 19 | 0.210 | + 0.145 | — | — |
| » | 8<br>10 March | — | + 0.570 | — | — |
| Kirtschin | 6—7 May | — | − 0.031 | — | — |
| Jangi-köl | 8—9 | — | − 0.008 | — | — |
| » | 10 | — | − 0.040 | — | — |
|  | 16 | — | − 0.111 | — | — |
|  | 18 | — | + 0.071 | — | — |

The table is thus very patchy, the cause being practically the fact that the observations were all taken at places selected at random. As for the transparency, the observations seem to point to the presence of a daily period, the simple and natural explanation of which is to be found in the position of the sun: the bright disk I used was more distinctly visible in proportion as the sun's rays struck the surface of the water at right angles; but when they struck it obliquely, the disk was less intensively illuminated. In rivers like the Mus-art-darja and the Ugen-darja, which in the late autumn are almost stationary, the transparency increases to a high degree, reaching as much as 0.78 m. In the lower Jarkent-darja too, where the velocity is but slight, the transparency increased to 0.39 m. Generally speaking this property is determined by three factors — the velocity, the character of the bottom, and the shape of the river-bed. The water is of course clearest where the bed is deep and narrow, and has a sluggish stream, and is very muddy where it is broad and flows with great velocity. Again, where there is an abundance of vegetation on the eroded banks, and these are permeated in all directions by the roots of plants, the water is naturally clearer; but where vegetation is absent, as it is in most of the «jangi-darjas», the water is always exceedingly muddy.

During the close of September and throughout almost the whole of October the river subsided slowly; but from the end of October a very slight rise could be detected, this the natives attributed to the return of the irrigation water into the main stream.

The height of the terraced banks was of course always taken on the inner side of the convex bends, and thus expresses the maximum value in every case. This datum varies however with the shape of the river-bed, and is approximately proportional to the breadth and depth of the river. The highest eroded bank I measured was 5.12 m. high, and the greatest difference I observed between the high-water level and the existing level amounted to 3.21 m., a value which is of course entirely dependent upon the shape of the river-bed and the velocity of the current. The two classes of value which I have last mentioned run therefore to some extent parallel. For instance, if the terraced bank is only 1.38 m. high, then the highwater level will be only 0.98 m. above the existing level. Still this cannot be laid down as a rule; for we had instances in which the terraced bank, although 2½ m. high, could be overflowed by the high-water, which then gave rise to temporary marshes.

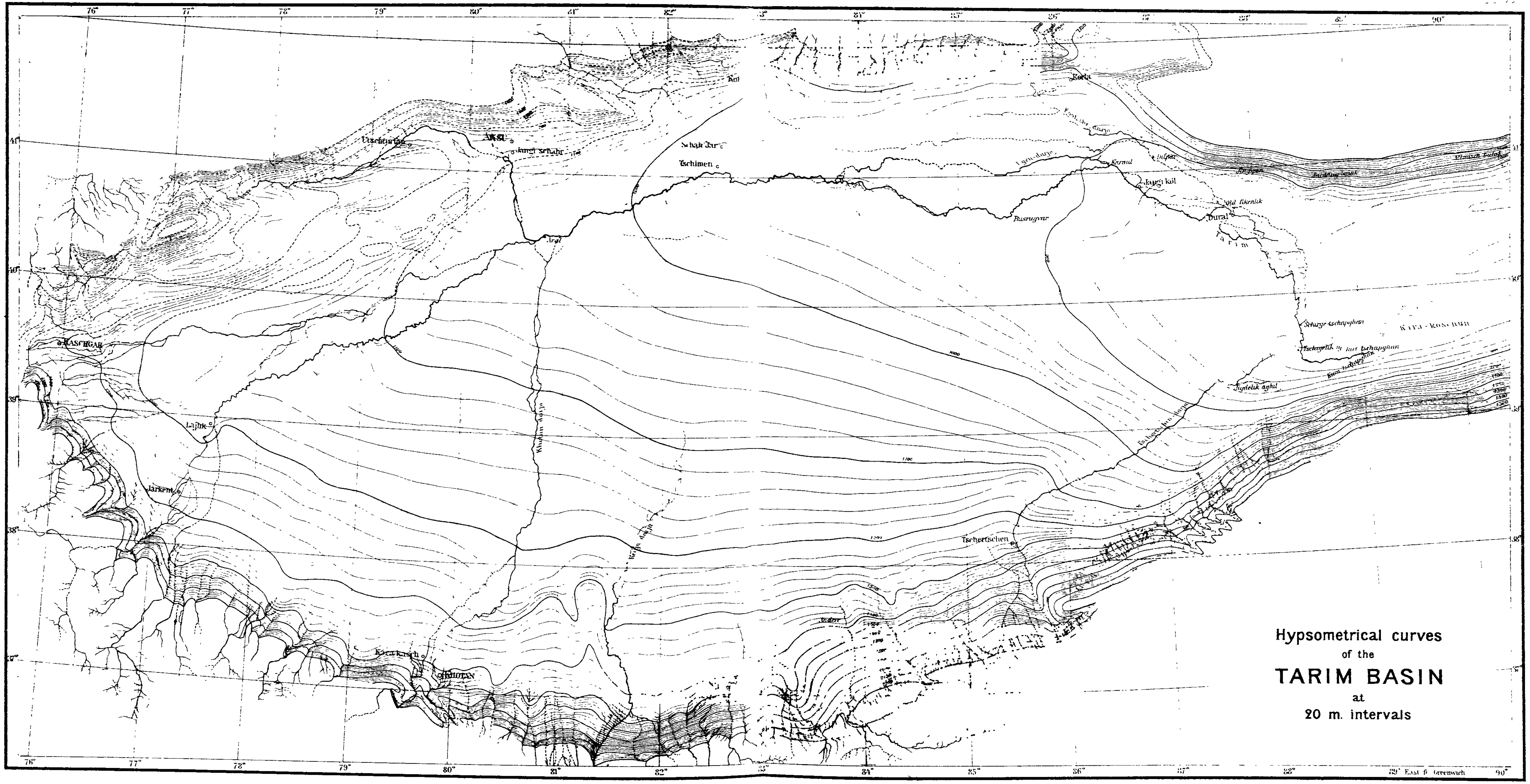
Finally, I may observe that the subjoined table contains an exhaustive list of all the measurements I made of the river.

| River. | Place. | Date | Vertical section Vol. I page. | Breadth. | Mean depth. | Maximum depth. | Mean Velocity. | Maximum Velocity. | Area of vertical section in sq.-m. | Volume in cub.-m per second. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1899.** | | | | | | | | |
| Jarkent-darja | Lajlik | Sept. 16 | — | 134.7 | 0.863 | 2.74 | — | — | — | 98.20 |
| » | Bisch-köl | » 18 | 16 | 86.40 | 1.229 | 2.22 | 0.7544 | 0.8928 | 106.16 | 80.09 |
| » | Schäschkak | » 19 | 17 | 42.60 | 2.274 | 3.90 | 0.6608 | 0.8463 | 96.87 | 64.01 |
| » | At-pangsa | » 21 | 18 | 69.30 | 1.434 | 2.30 | 0.5382 | 0.6789 | 99.38 | 53.47 |
| » | Schakkal-otak | » 22 | 19 | 35.30 | 2.965 | 4.98 | 0.6322 | 0.7440 | 104.66 | 66.16 |
| Kötäklik-darja (right arm) | Island | » 23 | 22 | 29.20 | 1.230 | 1.72 | 0.5715 | 0.7626 | 35.92 | 20.53 |
| » (left arm) | » | 23 | 22 | 34.20 | 0.613 | 1.01 | 0.5177 | 0.7440 | 20.97 | 10.86 |
| Jarkent-darja | Töländä | » 24 | 24 | 34.90 | 1.680 | 3.01 | 0.3431 | 0.4092 | 58.63 | 20.12 |
| » | Kum-atschal | » 25 | 25 | 48.00 | 0.753 | 1.07 | 0.4808 | 0.6696 | 36.14 | 17.38 |
| » | Läschlik | » 27 | 26 | 79.50 | 0.648 | 1.11 | 0.5910 | 0.8556 | 51.54 | 30.46 |
| » | Jalghus-jigde | » 28 | 26 | 40.80 | 0.975 | 1.45 | 0.5996 | 0.8835 | 39.78 | 23.85 |
| » | Kijik-tele-tschöl | » 29 | 27 | 52.60 | 0.929 | 1.86 | 0.5012 | 0.7905 | 48.84 | 24.48 |
| » | Haradighan-kötäk | » 30 | 28 | 51.00 | 0.620 | 0.78 | 0.6690 | 0.8091 | 31.62 | 21.15 |
| » | Kuruk-asti | Oct. 2 | 37 | 52.00 | 1.400 | 2.71 | 0.6238 | 0.6696 | 72.80 | 45.41 |
| | Sorun | » 5 | 41 | 53.18 | 1.297 | 1.86 | 0.3499 | 0.4464 | 68.96 | 24.13 |
| » | More | 8 | 47 | 67.3 | 0.656 | 1.21 | 0.5913 | 0.8091 | 44.13 | 26.10 |
| » | Milka | » 9 | 48 | 56.7 | 0.685 | 1.14 | 0.5533 | 0.7533 | 38.84 | 21.49 |
| » | Ak-satma | » 10 | 49 | 46.0 | 0.905 | 1.95 | 0.5500 | 0.5952 | 41.63 | 22.90 |
| » | Dugha-dschaji | » 11 | 49 | 27.0 | 3.090 | 4.90 | 0.2245 | 0.3162 | 83.43 | 18.73 |
| » | Tugha-pangsa | » 12 | 51 | 54.25 | 0.588 | 0.88 | 0.5699 | 0.7440 | 31.90 | 18.18 |
| » | Toghri-kum | » 13 | 51 | 54.1 | 0.728 | 1.32 | 0.4894 | 0.5580 | 39.40 | 19.28 |
| » | Islik | » 15 | 53 | 33.2 | 0.899 | 1.40 | 0.7531 | 0.8556 | 29.83 | 22.47 |
| » | Kujluschning-baschi | » 16 | 53 | 48.0 | 0.620 | 1.08 | 0.6611 | 0.7812 | 29.76 | 19.68 |
| » | Jar-kotan | » 17 | 56 | 19.55 | 1.204 | 1.92 | 0.7744 | 0.9300 | 23.54 | 18.23 |
| » | Aschi-dung | » 18 | 58 | 33.3 | 1.140 | 3.00 | 0.5183 | 0.7440 | 37.96 | 19.68 |
| » | Kalmak-kum | » 20 | 61 | 24.2 | 2.089 | 4.60 | 0.3117 | 0.8403 | 65.07 | 20.28 |

| River. | Place. | Date. | Vertical section Vol I page | Breadth | Mean depth | Maximum depth. | Mean Velocity | Maximum Velocity | Area of vertical section in sq-m | Volume in cub-m per second |
|---|---|---|---|---|---|---|---|---|---|---|
| Jarkent-darja. . . . . . . | Tscholak-dung . . . . . . | Oct. 21 | 62 | 27.1 | 1.006 | 2.10 | 0.5496 | 0.6075 | 27.25 | 14.98 |
| » . . . . . . . | Usun-jurt . . . . . . . . | 22 | 63 | 22.86 | 1.473 | 3.11 | 0.5227 | 0.5580 | 33.67 | 17.60 |
| » . . . . . . . | Matan . . . . . . . . . | 23 | 64 | 26.0 | 1.362 | 2.62 | 0.4488 | 0.7347 | 35.11 | 15.89 |
| » . . . . . . . | Hangetlik . . . . . . . . | 25 | 72 | 33.3 | 0.785 | 2.59 | 0.5026 | 0.7812 | 26.12 | 13.13 |
| » . . . . . . . | Jesi-köl . . . . . . . . . | 26 | 74 | 26.2 | 1.164 | 3.11 | 0.4906 | 0.6324 | 30.49 | 14.96 |
| Tarim . . . . . . . . . | Busuk . . . . . . . . . | 30 | 86 | 72.55 | 1.354 | 2.20 | 0.7547 | 0.9672 | 98.23 | 74.13 |
| » . . . . . . . . . | Intschkä. . . . . . . . . | Nov. 4 | 96 | 70.00 | 1.176 | 3.22 | 0.8932 | 1.4508 | 82.30 | 73.51 |
| » . . . . . . . . . | Teres. . . . . . . . . . | 9 | 101 | 52.4 | 1.600 | 2.75 | 0.7550 | 0.8928 | 83.84 | 63.30 |
| . . . . . . . . . | Tupe-teschdi . . . . . . | 14 | 105 | 41.1 | 2.218 | 3.48 | 0.7568 | 0.9672 | 91.17 | 68.99 |
| » . . . . . . . . . | Koral-dung . . . . . . . | 18 | 112 | 34.57 | 3.056 | 6.84 | 0.6010 | 0.6510 | 105.65 | 63.19 |
| » . . . . . . . . . | Sadik-bajning-arighi. . . . | 23 | 124 | 70.30 | 1.442 | 3.90 | 0.6589 | 1.0137 | 101.40 | 66.81 |
| » . . . . . . . . . | Al-katik-tscheke . . . . . | 26 | 136 | 45.18 | 2.094 | 4.47 | 0.7242 | 0.9579 | 94.59 | 68.50 |
| » . . . . . . . . . | Siva . . . . . . . . . . | 28 | 141 | 51.20 | 1.979 | 3.30 | 0.6633 | 0.8091 | 101.34 | 67.22 |
| . . . . . . . . . | Karaul . . . . . . . . . | Dec. 5 | 152 | 54.90 | 1.362 | 1.73 | 0.7400 | 0.8928 | 74.78 | 55.33 |
| Ugen-darja . . . . . . . | » . . . . . . . . . . | 5 | 152 | 23.46 | 1.756 | 2.20 | 0.2200 | — | 41.20 | 9.06 |
|  |  | **1900.** |  |  |  |  |  |  |  |  |
| Tarim . . . . . . . . . | Jangi-köl . . . . . . . . | March 2 | 164 | 87.50 | 0.994 | 2.97 | 0.4801 |  | 87.01 | 41.78 |
| » . . . . . . . . . | » . . . . . . . . . . | May 16 | 165 | 84.59 | 1.160 | 2.12 | 0.6729 | 0.9853 | 98.12 | 66.03 |
| Kirtschin branch . . . . . | Kirtschin . . . . . . . . | 23 | 176 | 6.40 | 0.463 | 0.92 | 0.2382 | 0.3999 | 2.07 | 0.71 |
| Tarim . . . . . . . . . | » . . . . . . . . . . | 7 | 177 | 42.60 | 1.588 | 1.95 | 1.3167 | 1.6833 | 67.64 | 89.06 |
| » . . . . . . . . . | » . . . . . . . . . . | 23 | 177 | 42.30 | 1.328 | 1.73 | 1.3990 | 1.7670 | 56.17 | 78.58 |
| Old Tarim . . . . . . . | Camp . . . . . . . . . | 28 | 184 | 22.66 | 0.999 | 1.38 | 0.5839 | 0.7533 | 22.63 | 13.22 |
| Adoke-kok-alasi . . . . . | » . . . . . . . . . . | 29 | 186 | 12.00 | 0.900 | 1.40 | 0.6648 | 1.0416 | 10.80 | 7.18 |
| Old Tarim . . . . . . . | » . . . . . . . . . . | June 1 | 190 | 33.70 | 1.114 | 1.53 | 0.5728 | 0.7347 | 37.54 | 21.50 |
| Jemischek-kok-alasi . . . . | Arghan . . . . . . . . . | 3 | 192 | 18.00 | 1.887 | 2.76 | 0.6359 | 0.7533 | 33.96 | 21.60 |
| Jätim-tarim . . . . . . . | » . . . . . . . . . . | 3 | 193 | 33.30 | 1.699 | 2.30 | 0.2077 | 0.3255 | 56.58 | 11.75 |
| Old Tarim . . . . . . . | » . . . . . . . . . . | 4 | 193 | 26.80 | 1.632 | 2.44 | 0.5005 | 0.5766 | 43.74 | 21.89 |

| River | Place. | Date. | Vertical section Vols I and II, page. | Breadth. | Mean depth. | Maximum depth. | Mean Velocity. | Maximum Velocity. | Area of vertical section in sq.-m. | Volume in cub.-m per second. |
|---|---|---|---|---|---|---|---|---|---|---|
| Tschong-tarim | Arghan | June 4 | 194 | 45.35 | 2.127 | 5.00 | | - | 96.46 | — |
| Almontschuk branch | Almontschuk | » 6 | 208 | 11.00 | 0.794 | 1.15 | 0.2005 | | 8.73 | 1.75 |
| Tarim | » | » 6 | 208 | 38.10 | 1.593 | 4.00 | 0.8353 | 1.0695 | 60.69 | 50.70 |
| Sejt-uj channel | Tal-kirtschin | » 6 | 209 | 7.25 | 0.998 | 1.45 | 0.2168 | 0.2790 | 7.24 | 1.57 |
| Küjüsch branch | | » 6 | 210 | 6.20 | 0.795 | 1.24 | 0.1934 | 0.2325 | 4.93 | 0.95 |
| Upper Channel | Schirge-tschapghan | » 10 | 214 | 4.80 | 0.363 | 0.55 | 1.1798 | 1.4136 | 1.74 | 2.06 |
| Lower Channel | » | » 10 | 215 | 5.85 | 0.457 | 0.76 | 1.4148 | 1.6926 | 2.67 | 3.78 |
| Tarim | » | » 10 | 215 | 47.23 | 1.887 | 3.49 | 0.6887 | 0.9207 | 89.12 | 61.38 |
| » | » | April 19 | 214 | 47.60 | 2.491 | 4.34 | 0.8590 | 1.0509 | 118.58 | 101.86 |
| » | Tschigelik-uj | June 12 | 217 | 42.73 | 2.545 | 5.06 | 0.5938 | 0.6975 | 108.76 | 64.58 |
| Tschertschen-darja | Mouth | » 21 | 222 | 22.70 | 3.074 | 4.70 | 0.0499 | 0.0837 | 69.78 | 3.48 |
| Tarim | Jurt-tschapghan | April 3 | II, 161 | 44.60 | 3.809 | 7.32 | 0.8303 | 1.293 | 169.88 | 141.05 |
| » | Kum-tschapghan | » 4 | — | 29.60 | 2.573 | 4.65 | 0.3078 | 0.465 | 76.17 | 23.45 |
| Kum-tschapghan branch | » | » 4 | | 24.80 | 1.040 | 1.60 | 0.3760 | 0.539 | 25.79 | 9.70 |
| Tusun-tschapghan branch | » | » 4 | — | 22.80 | 1.772 | 4.00 | 0.3975 | 0.586 | 40.41 | 16.06 |
| Tarim | » | » 10 | II, 153 | 30.00 | 2.601 | 5.09 | 0.3363 | 0.511 | 78.03 | 26.24 |
| Kum-tschapghan branch | » | » 10 | II, 154 | 22.60 | 1.243 | 1.99 | 0.3055 | 0.623 | 28.09 | 8.58 |
| Tusun-tschapghan branch | » | » 10 | II, 154 | 22.00 | 2.364 | 4.80 | 0.3729 | 0.558 | 52.00 | 19.39 |
| Tarim | Jurt-tschapghan | » 13 | II, 152 | 42.40 | 3.365 | 6.45 | 0.6023 | 0.781 | 142.65 | 85.91 |
| » | » | June 25 | II, 158 | 37.20 | 3.371 | 5.98 | 0.3143 | 0.381 | 125.40 | 39.41 |
| *A.* branch to new lake | N. shore of Kara-koschun | March 31 | II, 196 | 140.00 | 0.695 | 1.75 | 0.0321 | 0.158 | 97.36 | 3.12 |
| *B.* » » » » | » » » » | » 31 | II, 196 | 19.50 | 0.696 | 0.97 | 0.3243 | 0.632 | 13.57 | 4.40 |
| *C.* » » » » | » » » » | » 31 | II, 197 | 9.80 | 1.588 | 2.49 | 0.5572 | 0.828 | 15.56 | 8.67 |
| *E.* » » » » | » » » » | » 31 | II, 197 | 50.10 | 0.744 | 1.10 | 0.1913 | 0.391 | 37.27 | 7.13 |
| *F.* » » » » | » » » » | » 31 | — | 68.00 | 0.415 | — | 0.0680 | - | 28.22 | 1.92 |
| Tokus-tarim branch 1 | » » » » | April 1 | — | 9.81 | 0.440 | | 0.3165 | — | 4.32 | 1.37 |
| » » 2 | » » » » | » 1 | — | 10.35 | 0.483 | — | 0.7014 | — | 5.00 | 3.51 |

| River. | Place. | Date. | | Vertical section Vol. I page. | Breadth. | Mean depth. | Maximum depth. | Mean Velocity | Maximum Velocity | Area of vertical section in sq.-m. | Volume in cub.-ft per second. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tokus-tarim branch 3 . . . | N. shore of Kara-koschun . | April | 1 | — | 11.90 | 0.593 | — | 0.4424 | — | 7.06 | 3.12 |
| Tokus-tarim . . . . . . . | Narrow place . . . . . . | » | 16 | I, 445 | 16.60 | 1.270 | 2.16 | 0.4464 | 0.5766 | 21 08 | 9.41 |
| Upper branch . . . . . . | Schirge-tschapghan . . . . | » | 18 | I, 445 | 5.20 | 0.623 | 0.96 | 0.7525 | 0.9114 | 3.24 | 2.44 |
| Lower branch . . . . . . | » . . . . | » | 18 | I, 454 | 6.30 | 2.115 | 3.31 | 0.2033 | 0.3720 | 13.32 | 2.71 |
| Lajlik-darja . . . . . . . | Camp XXXII . . . . . . | » | 21 | I, 460 | 25.52 | 1.579 | 2.26 | 0.4616 | 0.7254 | 40.30 | 18.60 |
| Märdäk branch . . . . . | Kum-tscheke. . . . . . . | » | 23 | I, 468 | 11.06 | 1.491 | 2.30 | 0.3855 | 0.7068 | 16.49 | 6.36 |
| Ilek . . . . . . . . . . | » . . . . . . . | | 24 | I. 474 | 16.75 | 2.760 | 5.38 | 0.5134 | 0.6045 | 46.23 | 23.73 |
| Arka-köl branch . . . . . | Mouth . . . . . . . . . | » | 24 | I, 474 | 25.66 | 2.163 | 3.65 | 0.3920 | 0.4092 | — | 6.00 |
| Ilek . . . . . . . . . . | Islamning-uji . . . . . . . | » | 24 | I, 475 | 18.55 | 1.997 | 4.00 | 0.6129 | 0.7626 | 37.05 | 22.71 |
| Barat Kulning channel . . | Mouth . . . . . . . . . | | 24 | I, 475 | 10.60 | 1.120 | 1.82 | 0.4539 | 0.5022 | 11.87 | 5.39 |
| Ilek . . . . . . . . . . | Camp XXXV . . . . . . | » | 25 | I, 476 | 20.90 | 2.279 | 5.08 | 0.4614 | 0.5394 | 47.63 | 21.98 |
| Jätim-tarim . . . . . . . | Tägirmän . . . . . . . . | » | 27 | I, 486 | 28.60 | 1.593 | 2.66 | 0.4969 | 0.5859 | 45.57 | 22.64 |
| Ettek-sala . . . . . . . . | Scharkurun . . . . . . . | » | 28 | I, 490 | 29.15 | 3.081 | 5.78 | 0.4243 | 0.5115 | 89.81 | 38.11 |
| Jätim-tarim . . . . . . . | Above Channels . . . . . | | 28 | I, 491 | 24.61 | 1.348 | 2.63 | 0.1456 | 0.2232 | 33.17 | 4.83 |
| Channel to Kara-köl . . . | Mouth . . . . . . . . . | » | 29 | I, 494 | 11.00 | 1.438 | 2.75 | 0.4395 | 0.4929 | 15.81 | 6.95 |
| Bos-ilek. . . . . . . . . | Above Avullu-köl . . . . | » | 30 | I, 496 | 19.90 | 2.203 | 3.43 | 0.9080 | 1.0600 | 43.84 | 39.80 |
| » . . . . . . . . . | Above Tschivilik branches. | » | 30 | I, 496 | 20.22 | 2.631 | 4 35 | 0.2485 | 0.3720 | 53.20 | 13.22 |
| Jätim-tarim . . . . . . . | Near Kuntschekisch-tarim . | May | 1 | I, 500 | 11.98 | 1.215 | 2.02 | 0.5221 | 0.5580 | 14.56 | 7.00 |
| Kuntschekisch-tarim . . . | Near Jätim-tarim . . . . . | » | 1 | I, 501 | 51.25 | 2.629 | 3.55 | 0.6739 | 0.8556 | 134.76 | 90.81 |
| » . . | Säkitma. . . . . . . . . | » | 2 | I, 501 | 33.50 | 2.452 | 4.00 | 0,4419 | 0.5022 | 82.14 | 36.30 |
| Laschin-darja . . . . . . | » . . . . . . . . | » | 2 | I, 501 | 52.59 | 1.805 | 2.43 | 0.5584 | 0.6696 | 94.40 | 52.71 |
| Judaktane-kok-alasi . . . . | Mouth . . . . . . . . . | » | 3 | I, 503 | 6.10 | 1.305 | 1.80 | 0.1933 | 0.2139 | 7.96 | 1.54 |
| Kuntschekisch-tarim . . . | Camp XLII . . . . . . . | | 4 | I, 504 | 43.00 | 1.426 | 2.35 | 0.6314 | 0.7905 | 61.31 | 38.71 |
| Turkomakte-kok-alasi . . . | Mouth . . . . . . . . . | » | 4 | I, 505 | 12.20 | 2.627 | 4.20 | 0.4495 | 0.5208 | 32.05 | 14.40 |
| Kuntschekisch-tarim . . . | Above Kalmak-ottogho . . | » | 5 | I, 506 | 30.70 | 1.538 | 2.35 | 0 3956 | 0.5673 | 47.22 | 18.68 |
| Kalmak-ottogho . . . . . | Near Kuntschekisch-tarim . | » | 5 | I, 507 | 11.00 | 0.500 | 0.75 | 0.3232 | 0.4092 | 5.50 | 1.78 |



Hypsometrical curves
of the
TARIM BASIN
at
20 m. intervals

Gen. Stab. Lit. Anst. Stockh.

# THE HYPSOMETRICAL RELATIONS OF THE TARIM BASIN.

# CHAPTER XL.

## CONTOUR-LINES OF THE UPPER TARIM BASIN.

I have devoted two whole volumes of this work to a description of the Tarim and its tributaries, its lakes and surrounding deserts, but I have given no attention to the absolute altitudes, nor yet to the relative, though they are in many respects of great interest. The reason of this is that it seemed to me more desirable to discuss the hypsometrical data in connected form. In this and the succeeding chapter I will touch upon certain matters which arise out of them; and in Chapter XLII I will yield place to Dr. Nils Ekholm, who, in an interesting and important essay, has kindly given a general account of the manner in which he has dealt with my hypsometrical observations and of the different methods which he has employed in working them out.

Plate 58 is a map of the Tarim depression, designed to give a picture of the general shape of its basin. A single glance at it suffices to convince us of the great flatness and regular structure of the basin; it is only in the north-west that the contour-lines exhibit any irregularity, and there appears another slight departure from uniform regularity between the Chotan-darja and the Kerija-darja. Towards the bases of the mountains, that is to say the Tien-schan in the north, the Pamir in the west, and the Kwen-lun in the south, the curves become more crowded together, and if we attempted to trace them out up the relatively steep detritus scree, they would resolve themselves into a single continuous black mass on the map. How much more then would this result ensue did we attempt to follow them up in the mountains! But as a matter of fact it will be a long time before contours can be drawn for these mountains, which as yet are so imperfectly known. On the whole, our elliptical or oval basin bears in a high degree a resemblance to a spoon, the hollow of the bowl being at Kaschgar, and from there the fall slopes more and more gradually down to the tip of the spoon in the Lop country. The resemblance may even be carried one step farther, for just as a liquid contained in a spoon is poured out over its tip-end, so in like manner is the water that is contained in the Tarim spoon emptied out over its farther end in the country of Lop.

On the whole we find that the contour-lines run with tolerable regularity, so that each separate curve reproduces on a diminished scale the typical outline of the Tarim basin. The entire basin suggests therefore the outside of an oyster-shell, with its concentric rings, and here again the country of Lop is the umbo or hinge; the only difference is that, whereas the basin is concave, the shell is convex. In the immediate neighbourhood of the depression of Lop the curves run somewhat irregularly in consequence of the extraordinary levelness of the region. The data we possess for the north-western part of the basin, between the Tauschkan-darja and the Kaschgar-darja, are all too few to admit of anything more than a conjectural (dotted) indication of their positions.

Fig. 246. A »KOL» IN THE BED OF LOWER JANGI-DARJA (CHOTAN-DARJA) MAY 27, 1895.

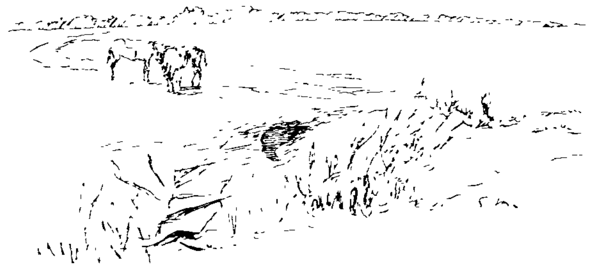


Fig. 247. A WATER-POOL IN THE DRY BED OF THE CHOTAN-DARJA, END OF MAY 1895.

The contours are drawn at intervals of 20 m.; the contours which designate the centuries, that is to say every fifth line, are printed in heavier type, so as to facilitate the use of the map. The materials consist exclusively of hypsometrical observations which I have taken myself in the Tarim basin, and which have been worked out in the way described below by Dr. Nils Ekholm. As I have not personally visited the northern parts of the country, from Maral-baschi to Ak-su and further *via* Kutschar to Korla, that part of the map falls somewhat short in accuracy. The same remark applies to the regions between Ak-su and Kaschgar *via* Utsch-Turfan and the Tauschkan-darja. Not that I have not visited that part of the country, but when I did visit it, I possessed no hypsometrical instruments, having lost them in my journey across the desert in 1895. Dr H. Keidel, who has recently visited this region, will be able to furnish us with very good observations of every kind. Nor have I been able to make use of hypsometrical data gathered by other travellers. The map of the Russian General Staff gives, for example, an altitude of 1006 m. for Ak-su, and this datum was adopted and used by Dr. Hassenstein in my large map in *Petermanns Mitteilungen.* But according to my observations the altitude at the mouth of the Ak-su-darja is 1031 m.,* and consequently on our little contour-map the Ak-su-darja is given an altitude of 1130 m. For Ak-su Pjevtsoff gives an altitude of 1036 m., while Kuropatkin puts it at 1067 m.; this last is in any case the best and most reliable observation. Although Littledale travelled along the whole of the northern side of the Tarim basin, he has not contributed one atom to our knowledge of its geography. Carey and Dalgleish adopt Kuropatkin's figure as the altitude of Ak-su. Pjevtsoff has given to Kutschar an altitude of 976 m., which agrees so well with my observation of 951 m. for Sor-sure on the same meridian, that I have been able to adopt it, and it prescribes the direction of the contour-lines over a considerable region in that quarter. Kuropatkin, Pjevtsoff, and the map of the General Staff all agree as to the altitude of Kutschar, possibly because the latter two adopted Kuropatkin's observation as being definitive and authoritative. Korla, which I found to lie at an absolute altitude of 949 m., is put by Pjevtsoff at 851 m., and by Kuropatkin at 915 m.; in this case again the last-named is the most trustworthy. The Baghrasch-köl is placed by the map of the Russian General Staff at 896 m., and this was adopted by Hassenstein in my map in *Petermanns Mitteilungen.* But he has at the same time committed the unaccountable error of giving to Korla an altitude of 956 m. (corrected subsequently to 949 m.); and yet this place ought of course to be considerably lower, seeing that the water flows from the Baghrasch-köl down to Korla. According to my observations, the Baghrasch-köl lies at an altitude of 1000 m.*

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* On the map, »Tibet and the Surrounding Regions», this point, the Tarim Ferry, is put at 945 m.

Fig. 248. THE JURUN-KASCH RIVER, CAMP I (1896), THREE DAYS NORTH OF CHOTAN.

Nevertheless it does not lie within the compass of my task to discuss critically the relative values of the observations made by different travellers. I only desire to explain why I have considered it best to rely solely upon my own material, all of it obtained with similar instruments, namely three aneroids and a boiling-point hypsometer, so that the observations were uniformly and systematically carried out, and are intimately related to one another, and these properties are still further enhanced by the patience and skill with which Dr. Nils Ekholm has calculated all the data. Consequently it may already be said, that the mutual positions which the actual hypsometrical lines follow must of physical necessity be such as are represented on the map. Indeed it would be possible simply from the directions in which the rivers flow to draw up a contour map of this region, which would reproduce the broad features of the actual shape of the basin, and thus approximate to the picture shown on Pl. 58. Of course I do not pretend to say that the lines on the map correspond to the reality in every detail. For instance, the great outcurving between the Chotan-darja and the Kerija-darja is not very probable, and possibly the deviation may only be due to a sudden change of atmospheric pressure. Anyway Pl. 58 reproduces the best results procurable with respect to this matter, and the number of observations intended to show altitude may also be regarded as sufficient. To have made use of the results of other travellers' determinations of height would only have marred the harmonious character of the map; for the important thing is, not the number of observations, but their reliability.

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* For Chotan the different altitudes vary from 1341 m. (Prschevalskij) to 1485 m. (Pjevtsoff). The mean between these two values, or 1413 m., approximates closely to my 1406 m. Grenard puts Chotan at 1370 m., and Stein puts it at 1369 m. The former would seem to come nearest to the real altitude, because Dutreuil de Rhins's expedition spent a long time at that town.

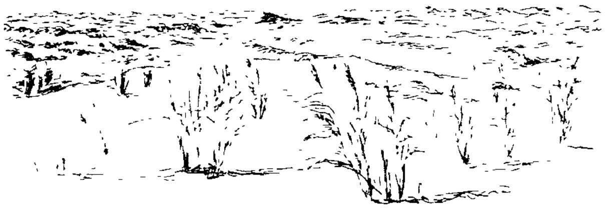


Fig. 249. THE DESERT EAST OF CHOTAN-DARJA.

Fig. 250. DUNES WITH TAMARISKS AND KAMISCH EAST OF CHOTAN-DARJA.

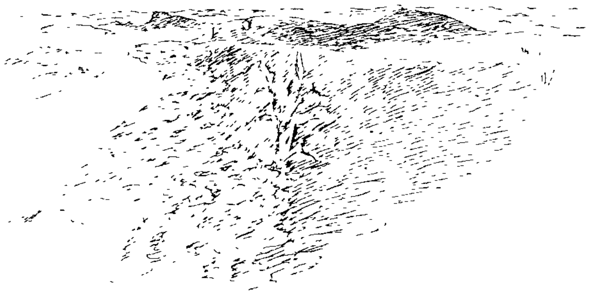


Fig. 251. DUNES BETWEEN THE CHOTAN-DARJA AND THE KERIJA-DARJA.

In what follows I propose, with the help of certain arithmetrical data, to attempt to convey some idea of the surface inclination in East Turkestan. In the majority of cases I have taken into account only those points the altitude of which has been directly determined; in other places I have resorted to interpolation. With regard to distances, I have measured them simply as straight lines on the little map to the scale of 1: 3,500,000; this makes their values of course very rough, and as no account is taken even of the very biggest windings in the rivers, the distances with which we now have to deal are in one or two cases somewhat shorter than those which I have quoted in earlier parts of this work and which do take account of the biggest of the windings. This does not however in any way affect the result, for our object is not to give exact distances, but only to obtain a common standard by which to compare the various degrees of steepness of fall in different parts of the basin. That is to say, it is gradients, not distances, that we want. Should any inquirer desire the latter data, he will have an excellent opportunity to measure them for himself when my general map on the scale of 1: 1,000,000 is ready and published in the atlas which accompanies this work.

When we consider the deepest line in the basin, namely that of the course of the Tarim, taken from Kaschgar to Kum-tschapghan, we find that in the eastward slope the gradients are not everywhere the same. Sometimes the 20 m. contour-lines lie closer together, sometimes farther apart. This might indeed be inferred from the varying velocity, regard being had of course to the windings and to the proportion which the length of the river bears to the distance in a straight line. Thus we always found, throughout our drift down the Tarim, that where the river had for a long time flowed in the same bed and had had sufficient opportunity to develop its windings on both sides, the velocity was less than usual, but where the river had deserted an old bed and had recently flung itself into a new one, in which no windings were as yet developed, the velocity was considerably greater, yet without the gradient along this latter stretch being in even the smallest degree different. The variations of velocity along the course of the river are however shown, partly by Dr. Ekholm's tables, partly from the table given below. The distance between Kaschgar and Kum-tschapghan in a straight line amounts to 1290 km., and along that distance the river falls 487 meters. If now we divide this distance into three equal sections, we see at once that the fall decreases as we advance towards the east. For from Kaschgar to the mouth of the Ak-su-darja it is 273 m., from the mouth of the Ak-su-darja to the Kurugen-ugen it is 119 m., and from the Kurugen-ugen to Kum-tschapghan it is 95 m. From Jarkent to Kum-tschapghan the distance, likewise measured in a long straight line, amounts to 1225 km., and along this line the fall is 455 m. But if we divide this distance into nineteen equal sections, each very nearly 65 km. in length, that is to say into sections equal to the distance between Jarkent and Lajlik, then the variations in the gradient are very distinctly seen. Thus the difference in altitude amounts between

| | | | |
|---|---|---|---|
| Jarkent—Lajlik | to | 99 | m. |
| Lajlik—Jajdi | » | 17 | » |
| Jajdi—Jughan-balik | » | 35 | » |
| Jughan-balik—Jigdelik | » | 39 | » |
| Jigdelik—Härrälik | » | 38 | » |
| Härrälik—Kara-ködschäk | » | 14 | » |
| Kara-ködschäk—Bitschanlik | » | 18 | » |
| Bitschanlik—Intschkä | » | 27 | » |
| Intschkä—Sor-sure | | 34 | » |
| Sor-sure—Sarik-buja | | 10 | » |
| Sarik-buja—Kara-akin | » | 5 | » |
| Kara-akin—Al-katik-tscheke | » | 17 | » |
| Al-katik-tscheke—Kischlak-uj | » | 11 | |
| Kischlak-uj—Baschtam | | 19 | » |
| Baschtam—Lakulluk | » | 21 | |
| Lakulluk—Kona-daghilik | » | 25 | » |
| Kona-dagilik—Tokta Kullune-köli | » | 12 | » |
| Tokta Kullune-köli—Ojman-köl | » | 12 | » |
| Ojman-köl—Kum-tschapghan | | 2 | » |

From this it is clear that on the whole the fall decreases towards the east, though with important oscillations.

The figures which I am now about to quote will also serve to give an idea of the different gradients in different parts of the Tarim basin. From the mouth of the Chotan-darja (1025 m.) to Kum-tschapghan (817 m.) the distance, measured in a straight line, amounts to 830 km. and the difference in elevation to 208 m., that is to say, the fall is 0.251 m. in each kilometer, or 1 meter in every 3990 meters. From Kaschgar (1304 m.) to the mouth of the Chotan-darja (1025 m.) the distance is 460 km. and the difference of elevation 279 m., or a fall of 0.607 m. in the kilometer or 1 meter in every 1649 meters. If now we compare the three lines radiating from the same point which we have already considered above, we obtain the following result: — between Jarkent (1272 m.) and the mouth of the Chotan-darja (1025 m.) the distance is 420 km. and the difference of elevation 247 m., giving a fall of 0.589 m. in every kilometer or 1 meter in every 1700 meters; between Chotan (1406 m.) and the mouth of the Chotan-darja (1025 m.) the distance is 410 km., and the difference of elevation 381 m., giving a fall of 0.929 m. in every kilometer or 1 meter in every 1076 m. It is however impossible to obtain a fully comparative measurement of the corresponding relations in the case of the Ak-su-darja, for, as I have already said, the altitude of Ak-su is uncertain. Suppose we take it at 1130 m., as shown on our little general map, and the mouth of the Ak-su-darja at 1031 m., then the difference of altitude in a distance of 110 km., measured in a straight line, amounts to 99 m., or 0.900 m. of fall in every 1 km., or 1 m. in every 1111 meters of length. That I have chosen the towns for my starting-point may appear arbitrary, but I have chosen them because they always stand on the transitional line between the mountains and the lowlands, and consequently are in that respect comparable. But even if, with the mouth of the Chotan-darja as centre, and any radius you please, say, for example, the distance to Lajlik, we draw a circle, it will be found that its circumference cuts the Kaschgar-darja at a point that is about 12 m. higher than Lajlik, and the Chotan-darja at a point nearly 130 m. higher; for while the altitude of Lajlik is 1173 m., the circumference of the circle cuts the Chotan-darja just at the point where the 1300 m. contour falls. And if we repeat the experiment from each of the three towns in turn, the result is in every case precisely that which I have set forth above.

One or two further examples of the same thing may be quoted. Kerija lies at an altitude of 1444 m. and the point at which the river once entered the Tarim — assuming that this river ran to some extent parallel with the Chotan-darja — namely in the district of Tschimen, lies at an altitude of 962 m. The difference in altitude is thus 482 m. in a distance of 480 m., or 1.004 m. in 1 km. or 1 meter in every 996 meters. Between Nija (1425 m.) and the Tarim at Kade-dung (942 m.) the distance is 448 km. and the difference of elevation 483 m., or 1.077 m. in 1 km. or 1 m. in every 927 m. Andere lies at an elevation of 1358 m. and Busrugvar, or the point where the Bostan-toghrak may be supposed to have reached the Tarim, at 916 m. altitude. The difference of elevation between the two points thus amounts to 442 m., and the distance in a straight line is 368 km.; consequently there is a fall of 1.201 m. in the kilometer or 1 m. in every 832 meters of length. Tschertschen (1251 m.) lies 360 km. from Kum-tschapghan (817 m.). The difference of altitude is here 434 m., that is 1.206 m. in the kilometer or 1 m. in every 829 m. of lineal measurement. If we proceed yet another step farther east we come to Tscharklik at an altitude of 925 m. and the point where the Tscharklik-su ought to strike the Tarim, at 818 m. Here we have a difference of elevation amounting to 107 m. in a lineal distance of 70 km., that is to say a fall of 1.528 m. in the kilometer or of 1 m. in every 654 m.

It will not be without interest to compare these latter figures one with another. In the Jarkent-darja the fall is 1 m. in 1700 m., in the Chotan-darja 1 m.

in 1073 m., in the Kerija-darja 1 in 996 m., in the Nija-darja 1 in 927 m., in the Bostan-toghrak 1 in 832 m., in the Tschertschen-darja 1 in 829 m., and in the Tscharklik-su 1 in 654 m. In other words the steepness increases constantly from west to east, a fact necessitated indeed by the shape of the entire basin. Consequently, the contour-lines run, as a glance at our map will show, increasingly closer together the farther we proceed east. This is true however only of the southern part of the basin; for on the northern side, that is alongside the Tarim, the circumstances are entirely the opposite, as we saw indeed along the stretch between Kaschgar and the Kum-tschapghan, where the distance between the 20 meter contour-lines increases towards the east. In consequence of this, the fall of the Kontsche-darja is approximately the same as that of the Tarim from the mouth of the Chotan-darja to Kum-tschapghan. Korla lies at an altitude of 949 m. and Kum-tschapghan at 817 m., so that the difference of altitude amounts to 132 m. over a distance of 455 km., indicating a fall of 0.290 m. in each kilometer or of 1 m. in every 3447 meters. If we treat the Kuruk-darja in the same way, making use only of the measured altitudes that we possess of its course, namely

| | |
|---|---|
| Kalta . . . . . . . . . . . . . . | 882 m. |
| Jing-pen . . . . . . . . . . . . . | 860 » |
| Camp of 13 March . . . . . . . . | 850 |
| » » 14 » . . . . . . . . | 836 » |
| » » 19 » . . . . . . . . | 826 » |
| Noghusun-tu . . . . . . . . . . . | 810 » |
| Camp of 29 March . . . . . . . . | 808 » |

we obtain for a distance of 240 km. a difference of elevation amounting to 74 m., or 0.308 m. in every kilometer or of 1 m. in 3243 m. If however we assume that the depression of Lop was in its time filled with water up to the same level as now, then the Kuruk-darja would terminate at an altitude of 816 m., and the fall would be 0.275 m. in 1 km. or 1 m. in 3636 meters; which is almost precisely the same as in the existing Kontsche-darja.

A comparison between the course of the Tarim from Karaul to Arghan and the contour-lines in the interior of the basin as shown by my determinations of altitude suggests some interesting reflections. When crossing the desert from Jangi-köl to Keng-lajka we found the country rise 258 m. in a distance of 280 km. measured in a straight line, giving a rise of 0.921 m. in 1 km. or of 1 m. in every 1085 m. If on the other hand we follow the meridian of Jangi-köl southwards, the distance works out at 220 km. and the difference of elevation at 109 m., for Dung-aghil lies at 990 m.; consequently the fall here is half a m. per kilometer or 1 m. in every 2000 meters. The peculiarity of this is that the rise is in exactly the opposite direction to what it is some distance farther east, where the fall, as the course of the Tarim shows, is from north to south; and the same thing is true of the old bed of the Ettek-tarim.

What I desire however to call attention to is the circumstance that, equally whether one travels along the line through the bajir depressions by which I crossed over the Desert of Tschertschen, or whether one travels along the meridian of Jangi-

Fig. 252. KERIJA-DARJA AT CAMP. XVII (1896).

Fig. 253. SATMA OF SARIK-KASCHME, KERIJA-DARJA, CAMP XVIII.

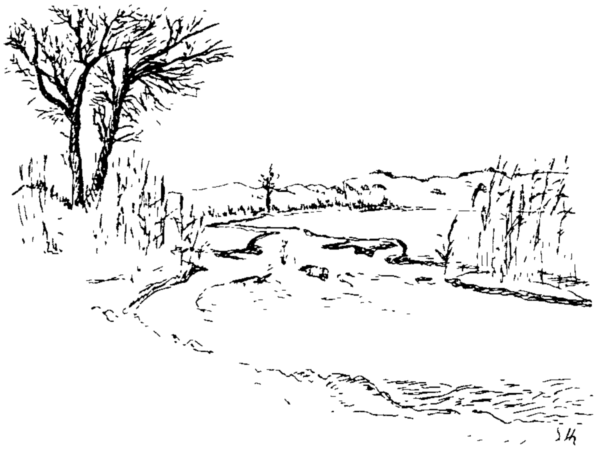


Fig. 254. KERIJA-DARJA CAMP XX.

köl, one crosses over a depression in the northern half of the Desert of Tschertschen situated, as the map shows, at a considerable distance south-west of the right bank of the Tarim. When travelling south-south-west from Jangi-köl, we thus descended a little at first, and it was not until we had passed the middle of the desert that we began to make any appreciable ascent toward the Tschertschen-darja. At the point where we left the Tarim, midway along the Tana-baghladi-köl, the absolute altitude was 882 m. Our 18 camping-stations in the desert, counting from that point and proceeding south, had the following altitudes — 884, 883, 888, 869, 880, 889, 883, 907, 906, 935, 983, 1015, 1020, 1051, 1089, 1142, 1141 and 1139 m. The last-mentioned point is Keng-lajka on the Tschertschen-darja; the two points immediately preceding it indicate the slight swelling which prevents the river from cutting its way north through the desert as the Chotan-darja and the Kerija-darja do. The lowest point is our fourth camp of 23rd Dec. 1899, where the altitude amounts to only 869 m. The camp of the 24th Dec. has an altitude of 880 m., and consequently lies at all events lower than our point of departure on the Tarim. It may seem rash to attach so much importance to observations which were taken only twice at each point, namely evening and morning, with aneroids and boiling-point thermometers. Nor should I indeed place such great reliance upon it were it not that there exist other circumstances which render it probable that they are correct. One of these circumstances is the creation of the numerous marginal lakes on the right bank of the Tarim in which we found depths of as much as 11 m.; this proves, apart altogether from the use of hypsometrical instruments, that the country immediately south-west of the Tarim actually is lower than the river and its low-lying banks. The south-western extremity of the lagoon of Basch-köl is 18.5 km. from the bank of the Tarim. But just as the Basch-köl itself fills as it were a big bajir depression, so does its lagoon fill another smaller bajir. To this it might be objected, that if the surface goes on falling towards the south-south-west, the water also would continue to flow in the same direction. But in this connection I would beg to recall the theory with regard to the origination of the bajir depressions which I have given in vol. I. The lagoon lies in a hollow and is prevented from flowing farther to the south-south-west by a threshold.

If however these thresholds between the bajirs did not prevent the water from penetrating farther into the desert, how far would it proceed before it was definitively stopped by the general rise of the surface in the direction of the mountains on the southern side of the desert? To this question we can get at any rate a provisional answer in the altitude which I have just quoted above. At Camp V of 24th December, at 880 m., we were still lower than our point of departure at the mouth of the Tana-baghladi canal, although the distance (see vol. I p. 312) amounts to 77.5 km. As Camp VI lay at 889 m., we may fairly assume that for some kilometers south of Camp V the country still continues to be lower than at our point of departure (see Pl. 13 of the Atlas). Let us therefore say that on the right bank of the Tarim a zone of not less than 80 km. lies lower than the river itself. Under these circumstances therefore it ought not to occasion the smallest surprise when we find that along that lacustrine stretch the river is step by step working its way towards the south-west. The surface inclines indeed in that direction, and not even the dunes, 90 m. high though they are, avail to put any real obstacle in the river's path. Consequently it is not at all impossible that the Tarim should continue to penetrate in the direction indicated until it reaches the deep depression, notwithstanding that, as we have seen, other parts of the lowest course of the river are tending in the diametrically opposite direction. When we consider, on our little hypsometrical map, the contour-lines for 860, 880, and 900 m., it almost

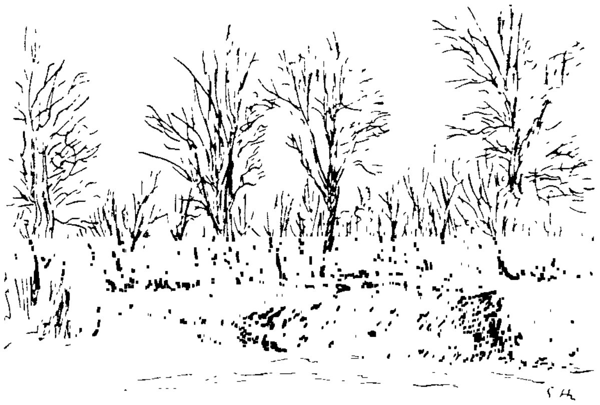


Fig. 255. KERIJA-DARJA, CAMP XXI, SHARP-CUT EROSION-TERRACE.

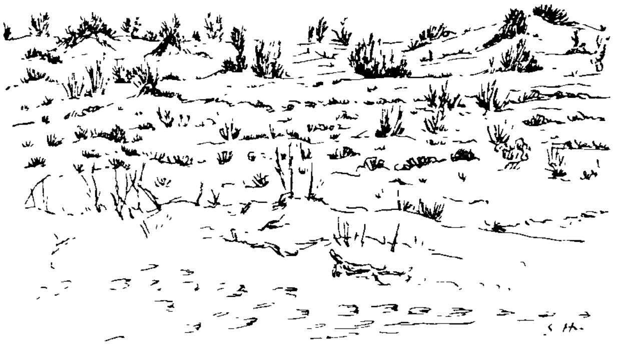


Fig. 256. DESERT AT CAMP XXII, NORTH OF KERIJA-DARJA.

Fig. 257. VIEW LOOKING NORTH FROM CAMP XXII BESIDE THE LOWER KERIJA-DARJA (1896).

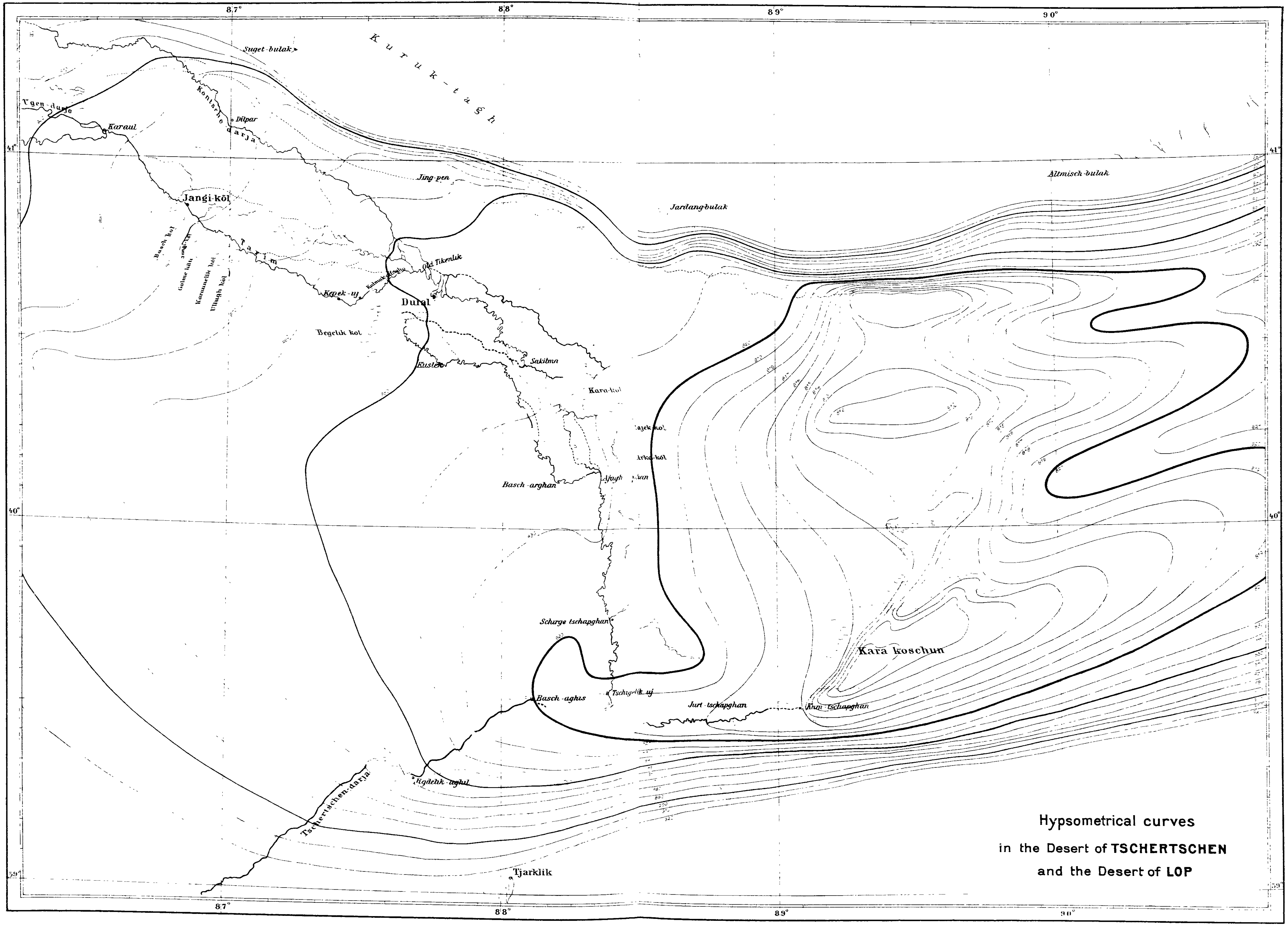
looks as if the river were really being invited to take its course through the depression which these contours indicate. Indeed the Tarim has actually taken one step in the direction pointed out, namely in that section of its course in which we drifted entirely through the sandy desert, above Busrugvar. If this section of the river were continued towards the south-east through the depression indicated by the contour-lines that we are considering, it would abandon the whole of its inland delta and would proceed direct to Tschigelik-uj. But before it can do that, the Tarim will have to wash away the masses of sand which bar its path, and indeed this is really only a question of time. However, it is probable, that the Tarim will not continue to press in that direction, but on the contrary will carve out new paths for itself to the lowest depression in the Lop country, namely the old bed of the Lop-nor.

Our little hypsometrical map, Pl. 58, is also capable of yielding at first hand certain other data of value, such as, for instance, the mean elevation of the entire basin of the Tarim, as well as the mean elevation of different sections of the same; hence I need waste neither time nor space by dwelling upon them. Such figures do not indeed possess *per se* any real value, for the map gives us the approximate elevation of every point of the basin to within 10 m. On the other hand these data would be more interesting were we able to compare them with similar values for the Tsajdam basin; yet as this latter is but little known, and in its interior, central parts is practically not known at all, we are for the present forced to abstain from any such comparison, in the hope that Barrett and Huntington, who left London on 3rd February 1905 for Tsajdam and East Turkestan, will be able to supply us with more abundant material.

Fig. 258. DUNES WITH SAKSAUL. CAMP XXIX (1896) BETWEEN KERIJA-DARJA AND TARIM.

Fig. 259. A SOLITARY TOGHRAK IN THE DESERT NORTH OF KERIJA-DARJA, CAMP XXVII.

There is another question connected with the distance calculations along the rivers which I feel I ought not to pass over, more particularly as it has reference to Pl. 2 to Pl. 11 of my atlas, that is to say sheets of it which are already published. These sheets were constructed by Major H. Byström on the basis of my calculations for velocity, that is to say, my measurements of the river, and his work was finished before the material of my astronomical observations for seventeen stations had been worked out. The consequence is that the distance between Lajlik and Karaul is made too short; the reason being that as a rule I was unable to measure the velo-



## Hypsometrical curves
## in the Desert of TSCHERTSCHEN
## and the Desert of LOP

city just in those places in which the current ran strongest, for it was there that the ferry-boat was carried along at its swiftest and the whole of my attention was engrossed with mapping. After the stretch in question was worked out, drawn, and printed, it turned out, upon comparing it with the positions as calculated astronomically, that it had been made 80 km. too short. When the length of the seventy days' drift was calculated as straight lines from camp to camp on the map I am alluding to, the total amounted to 738.830 km., or in round numbers to 739 km. When the same distance was calculated after the incorporation of the map in question into the general map constructed with degrees of latitude and longitude on the scale of 1: 1.000,000, the same stretch of the river, namely from Lajlik to Karaul, amounted to 819 km. The only effect of this error is that the scale of Pl. 2 to Pl. 11 ought to be 1: 110,800, instead of as now 1: 100,000; and this is the fact to which I desire to draw attention thus early. In all the succeeding sheets Major Byström and Lieut. Kjellström have had an opportunity of availing themselves of the astronomical determinations, and thus have been able to correct the distance as determined by my mapping of the river day by day. In the general criticism, as also in the text to the maps, a legend will in future be appended to each separate sheet. If, keeping to the scale of 1: 100,000 in Pl. 2 to Pl. 11, we follow the Tarim through all its windings, we obtain 1256 km. as the distance between Lajlik and Karaul; but if we employ the true scale of 1 : 110,800, we get the correct distance, namely 1392 km. Hence the Tarim regarded as a straight line stands to the Tarim with its windings counted in as 819 km. to 1392 km., or approximately 7 to 12. In other words, the journey down the river is almost twice as long as it is by land, using the shepherds' tracks that run along the banks of the Tarim.

# CHAPTER XLI.

## HYPSOMETRICAL RELATIONS OF LOWER TARIM BASIN AND OF KURUK-DARJA.

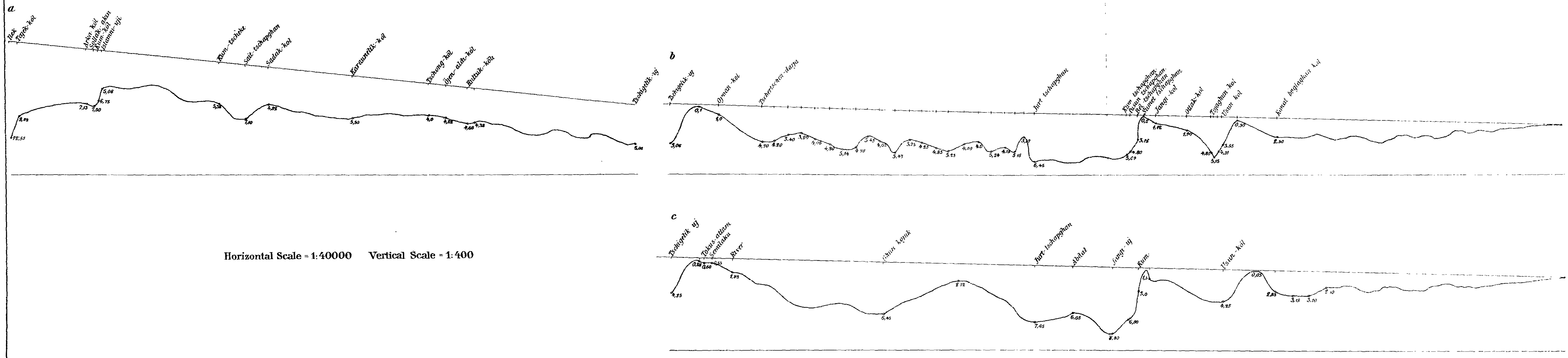
Let us now devote a few words to Pl. 59, which reproduces the contour-lines of the country around the lowest part of the Tarim down from Jangi-köl, and between the Desert of Tschertschen on the west and the Desert of Lop on the east. The contour-lines between 920 and 820 m. are shown for every tenth meter, but below 820 m. for every single meter. That these latter cannot be more than approximate is self-evident, for we possess only one single line, namely that which I levelled, with regard to which we can venture to speak with full certainty. Apart from that we have to rely upon such assistance as is afforded by the position of the rivers and by interpolation. In Dr. Ekholm's tables I have altered the altitude of one or two points in the eastern waterway. The results obtained go to show unmistakably that the eastern waterway lies, as indeed might be expected, at a lower level than the corresponding part of the Tarim; nevertheless its lowest part is somewhat the higher, because the water flows from Sadak-köl to Schirge-tschapghan. What the relation is that obtains between the possible connecting channels between the Tarim branches and the eastern Ilek I have been unable to ascertain. In some places the water flows from west to east, as for instance in the Ilek, which enters the Suji-sarik-köl, and in other places in the opposite direction, as the Almontschuk-kok-alasi. The most probable explanation would appear to be, that both waterways lie at one and the same level. Yet the northern part of the eastern waterway certainly lies lower than the Tarim, and consequently I have here made the 830 m. contour-line describe an angle. Thus the contour-lines for 830 and 840 m. make it appear as though the Tarim flowed upon a terrace, but for this three separate explanations readily suggest themselves. In the first place, the Tarim builds up ramparts for itself, so that as an actual fact the river does flow at a higher level than the level of the adjacent country; in the second place, we have found that the region south-west of this part of the Tarim actually does lie at a lower level than the river; and in the third place, we must remember, that in this part of its course the river's position is prescribed by already existing bajir depressions, so that for long distances the stream is confined within proper bounds by the elevations between the old bajir depressions.

In general there exists a great and beautiful agreement between the contour-lines of the Tarim and those of the Kontsche-darja and the Kuruk-darja. The contour-line of 820 m. may be said to form the boundary between the true Lop region, with the depression of Kara-koschun to the south and that of Lop-nor to the north. For the course of the contour-lines in the western part of the interior of the desert there is nothing better to build upon than conjecture, for nobody has ever been there. The altitude 802 m. shown in my itinerary across the desert in 1900 may be regarded as improbable, even though the advance of the desert lakes in that direction does point to the presence of low-lying country. It is interesting to observe, that the altitude 808 m. occurs precisely at the spot in which the Chinese maps place the Lop-nor, as also almost exactly opposite to the lowest part of the crossing I made in 1901, where the camping-ground at 815.3 m. is indicated. From my surveyed line alone no conclusion can be drawn with regard to the exact position of the Lop-nor, that is to say, it is impossible to determine whether this line crosses the eastern or the western part of the old lake basin. Nevertheless there exist several circumstances which suggest that the greater part of the lake-basin lay west of the line surveyed, and that this line consequently crosses the eastern portion of the Lop-nor, where the lake was relatively narrow. Hence the basins of the old lake as shown on Pl. 37 have turned out smaller than they ought to be, that is in relation to the Kara-koschun. The picture which the Chinese maps give of Lop-nor, the situation of the Kara-koschun, the flow of the water of Kara-koschun towards the north-north-east — all indicate that the greater part of the Lop-nor lay west of the line I levelled, the other properties of which, as well as the lessons it has to teach us, I have already dwelt on in the preceding pages. But the contour-lines from meter to meter which I have inserted on Pl. 59 are however only approximately trustworthy. Along the levelled line I did not consider it necessary for this purpose to make use of any other altitudes except those which coincide with the seven camps we made. Further, I have divided the old Lop depression into two basins, the southern one containing the Lop-nor proper and the northern one the three small lakes shown on the Wu-tschang map. Yet it is not this map alone which corroborates the correctness of the conception. The relative swelling, on which the ruins of Lôu-lan are situated, would appear to project westwards between these two basins. Further, we find close to the foot of the mountains two points with altitudes of 810 m., which, altogether independently of the Chinese maps, would have forced us to push back the contours towards the north. How far it is an actual elevation of the ground which separates these two depressions from one another it is difficult to say; in that case it will certainly have been pierced in one or even several places by canals from the small lakes, to communicate with the great Lop-nor. The flow of the water towards the north-north-east renders it necessary to posit the existence of a connecting-channel between the two lake-basins, the Kara-koschun and the Lop-nor. On the map I have shown the former, the southern lake, as though it contained no water. The lowest point that I sounded in its basin lies at an absolute altitude of 811 m.

I have said, that notwithstanding the abundant detail in the points measured hypsometrically along my surveyed line, this latter appears on Pl. 59 delineated with regard to its contour-lines in the same rough way as the other parts of the Lop region. And yet how inconceivably complicated are the contour-lines precisely along that line, as they are indeed for the matter of that in any of the other sand-free parts of the Lop Desert! To reproduce that complexity is of course quite impossible. It is only necessary to imagine a jardang extending for kilometers, being in general 2 to 3 m. high, along the sides of which the contour-lines would run for hundreds of meters! Then, bearing in mind that the entire desert is crammed with jardangs, and it is possible to conceive what the resulting map would be like. In order to render this still clearer I have on Pl. 60 at great pains drawn the meter contour-lines to a rather large scale, and have further had regard to the decimeter contour-lines as well. The positions of the curves outside of the ascertained line are idealised in the light of the experience that I possess as to the plastic features of the desert. They represent the jardangs and the hollows between them: they may in reality be longer or shorter than I have drawn them, but the chief object was of course to give a general idea of their arrangement. For the sake of simplicity I have made the line straight on north and south, although in reality it is somewhat convex towards the east. Further, I have made all the distances equally great, that is to say 200 m., although towards the south they actually amount to 282 m. Finally, I must remind the reader that in this little sketch I have considered that there is only *one* wind-eroded gully between every pair of measured points, whereas in point of actual fact as many as 50 gullies may be embraced within a distance of 200 m. So that in order to correspond to the reality, the sketch ought to possess as much detail in the drawing, but to be fifty times longer. It *is* a bold thing to lay down these contour-lines on the strength of only *one* measured line, but my only object is, as I have said, to give an idealised picture. The parts coloured blue are those that lie below the level of the Kara-koschun. From that it will plainly be seen, that on several occasions I crossed over narrow projecting bays and arms of the lake pointing towards the north-west. Had they been followed up westwards they would have been found to terminate in what were at that time vast expanses of open water. In the jardang desert all the points I measured stand on the top of the jardang ridges; but in the schor desert the lines run more simply. Pl. 60 ought to be compared with Pl. 36 and Pl. 37.

If any one, after reading my description of the wind-eroded gullies and jardangs in the preceding pages, and after seeing the photographs I have given, should still entertain any shadow of doubt as to the mode of their formation, Pl. 60 will, I am sure, infallibly convince him, that it is solely and alone the wind, using sand as an abrasive, that can have given rise to the remarkable regularity of the relief.

On the little sketch-map on Pl. 41 I have drawn a parallelogram, a study of which will still further help to elucidate the hypsometrical relations in the Desert of Lop. In the preceding chapter we have already seen how the surface of the Tschertschen Desert rises from north to south, as also how the Kuruk-darja, the Kontsche-darja, and the Tarim show a constant fall towards the south-east. The Tschertschen-darja falls towards the north-east. If the line which represents the second of the rivers just mentioned, the Kontsche-darja, be prolonged, and if at the same time the line of the Tschertschen-darja also be prolonged, these two lines will intersect one another in



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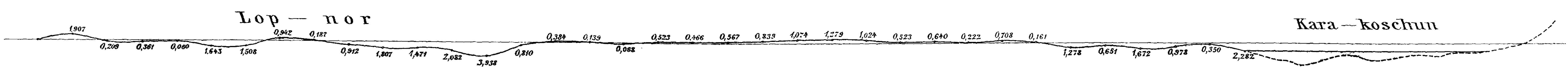

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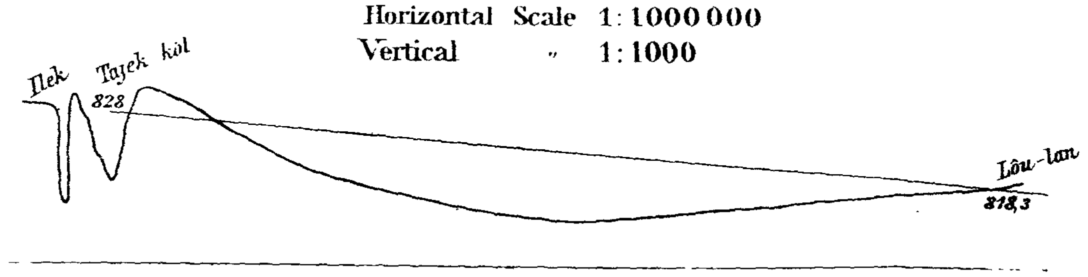

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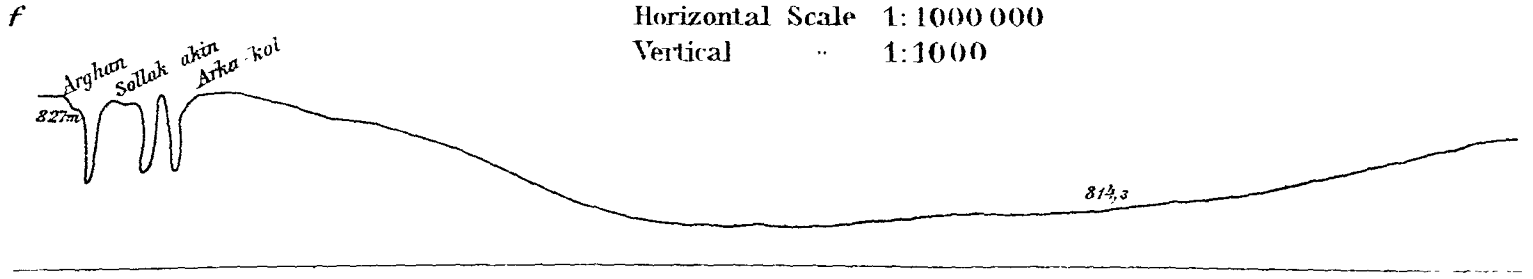

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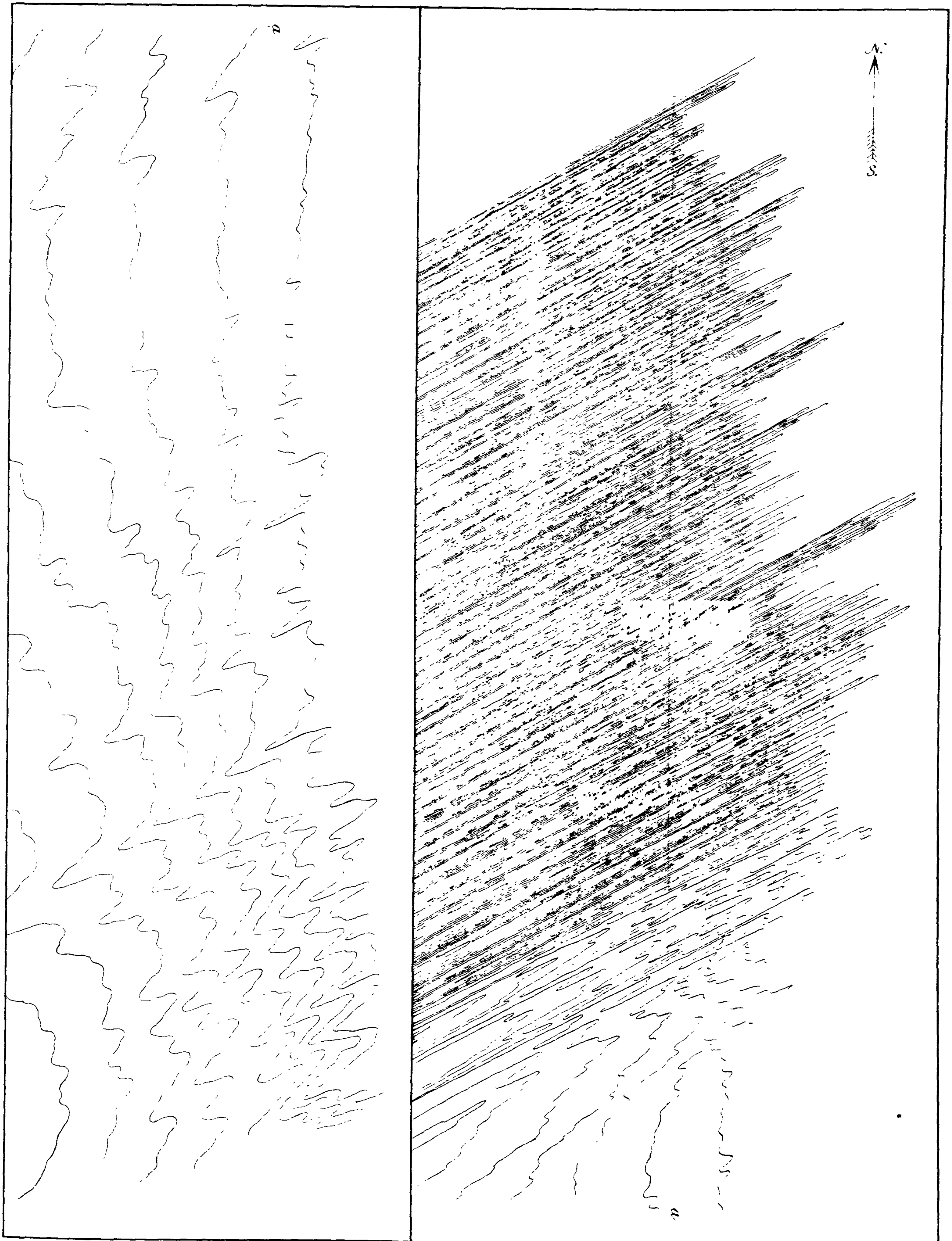
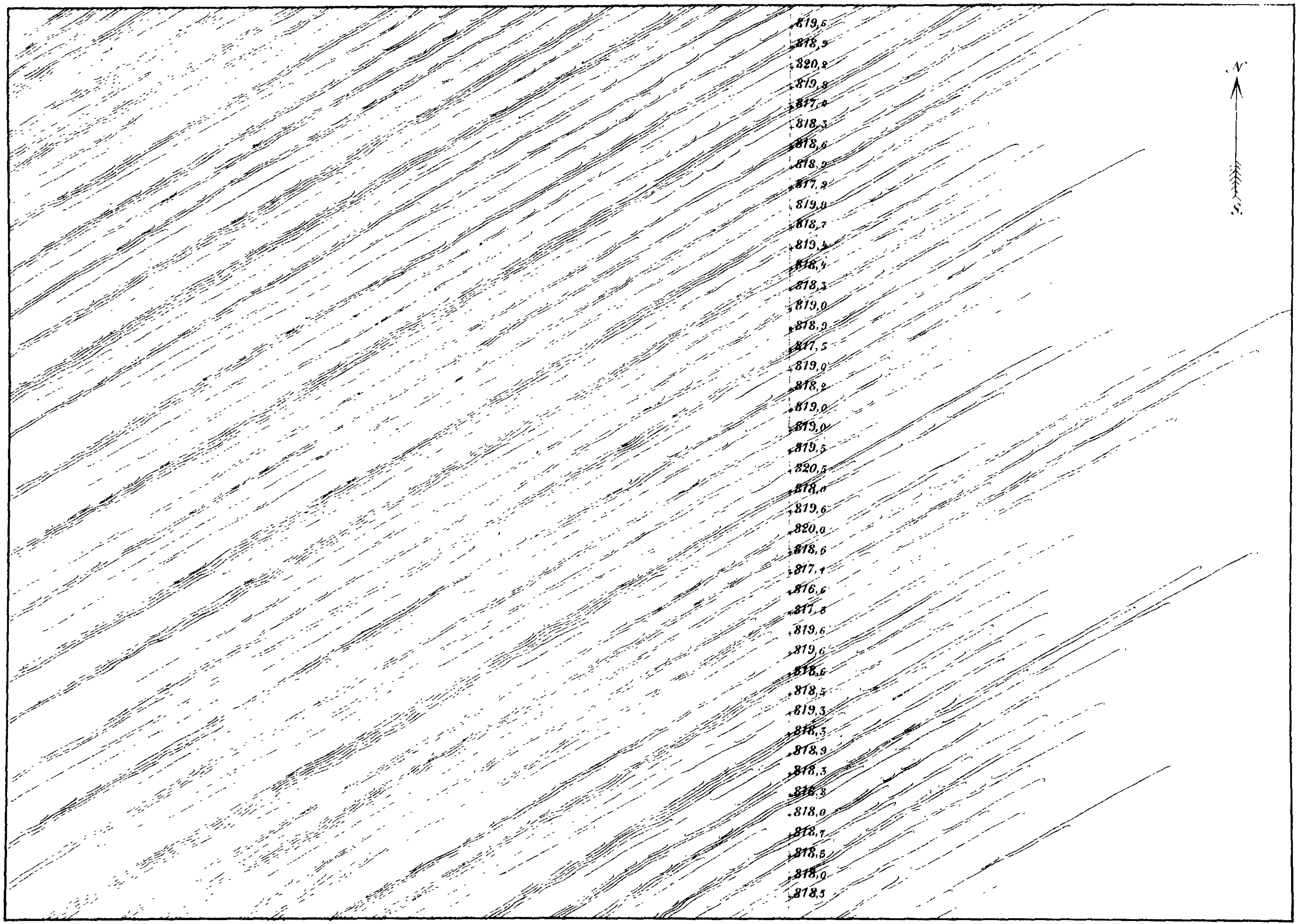


HYPSOMETRICAL CURVES IN THE DESERT OF LOP, ON THE LEVELLED LINE.

Scale 1: 160000

Gen Stab Lit Anst



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# HYPSOMETRICAL CURVES OF A PART OF THE LEVELLED LINE.

Skala 1: 37000

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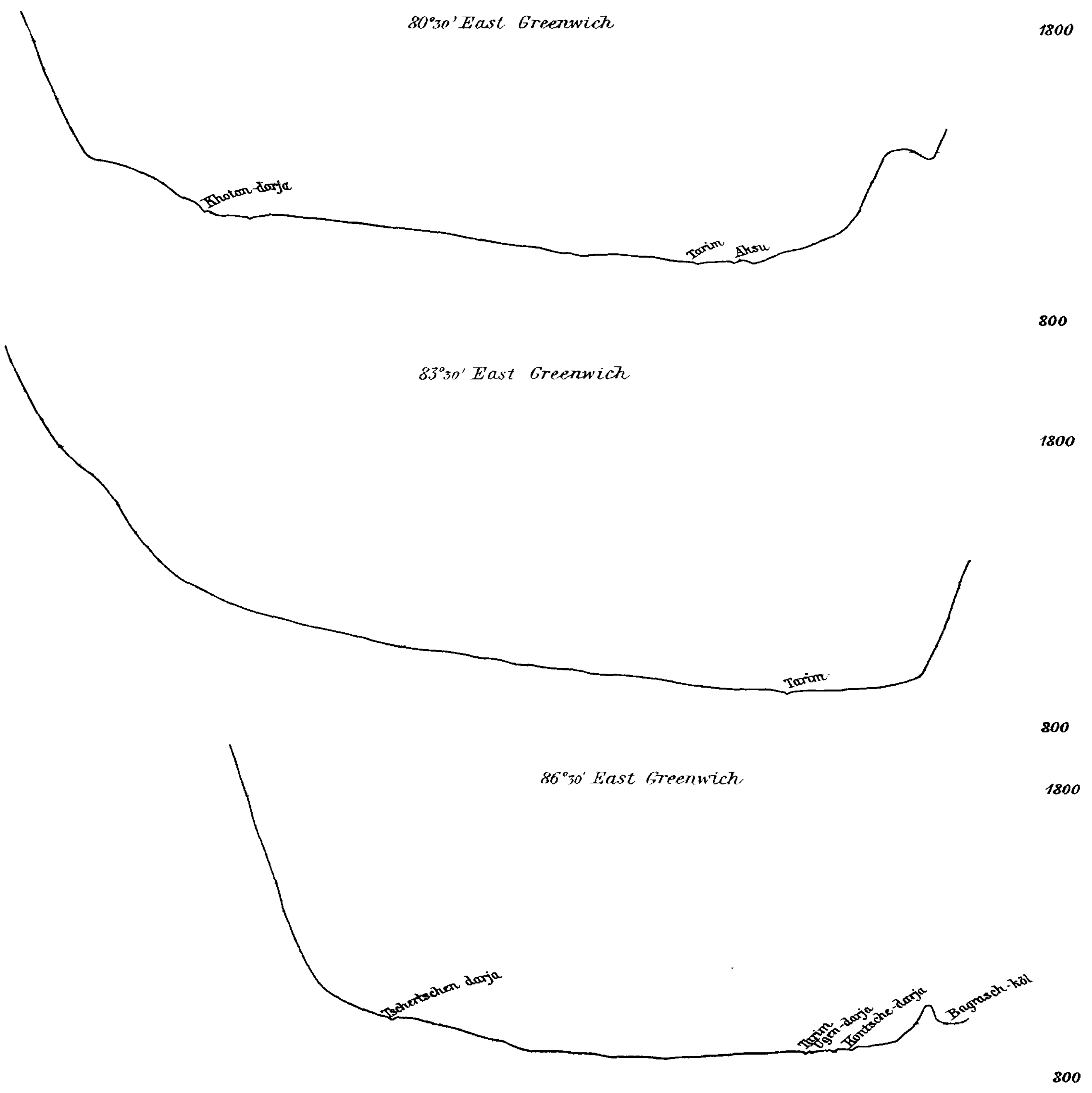

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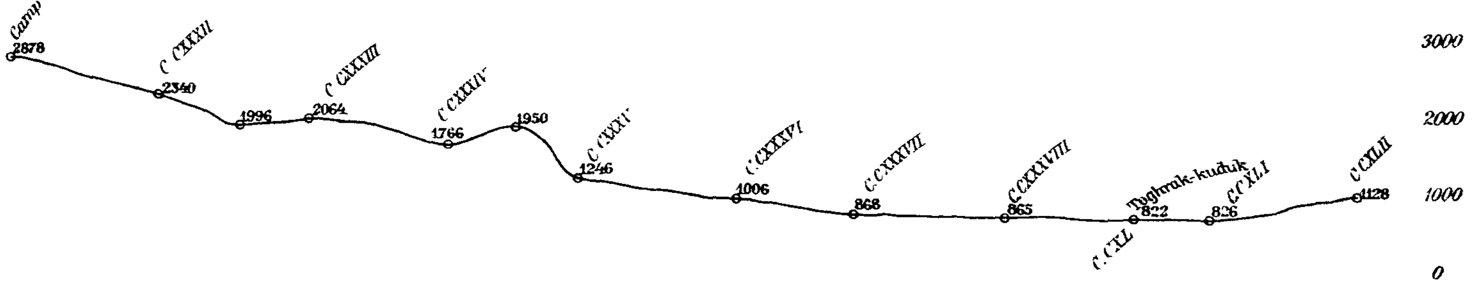

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the heart of the Desert of Lop, or precisely in that part of it in which we now find the newly formed lakes. If now we consider the meridional line which represents my route across the Desert of Gobi, between Anambaruin-gol and Camp CXLII, a distance of 168 km., it will be seen to exhibit in an excellent manner the same trough-like shape as the country of Lop, though the trough is much more energetically indicated, not so much because it is deeper, as because the bordering mountains are very much higher. But for the purpose of comparing the flat lands in question it will be sufficient to consider that part of the line which lies between Camp CXXXVI (1006 m.) and Camp CXLI (826 m.). We then have a fall towards the north of 180 m. in a distance of 60 km., measured in a straight line, that is to say, 3 m. in the km. or 1 m. in every 333 meters. But this line cuts a point that lies yet lower still, namely Toghrak-kuduk, which has an altitude of 822 m., or only 6 m. above the surface of the Kara-koschun. The altitude of Atschik-kuduk is, according to Dr. Ekholm's calculation of my observation, 833 m. With these two last-mentioned determinations the values given by Kosloff are so far in agreement that they may be regarded as probable. But I should at the same time observe, that for the Kara-koschun he retains Prschevalskij's altitude, which is 24 m. too low. For the space between the Kara-koschun (792 m.) and Atschik-kuduk he gives the following altitudes:

| | |
|---|---|
| Tschindejlik | 802 m. |
| Koschalantsa | 838 |
| Korat-bulak | 811 |
| Kuduk | 869 |
| Tatlik-kuduk | 808 |
| Toghrak-kuduk | (819) * |
| Atschik-kuduk | 829 |

All these points are situated in the depression which forms the immediate eastward continuation of that which begins in the Desert of Tschertschen, south-west of Basch-köl, and stretches across the Kara-koschun, which indeed occupies its lowest part. This deep trough is curved like a bow; its most westerly part lies close to the foot of the mountains on the northern side of the basin, its middle part under the foot of the Astin-tagh, that is at the southern side of the basin, and its eastern part at the foot of the Kuruk-tagh, that is back again at the foot of the northern mountains. To the north of it runs, and on the whole parallel to it, the curve of the depression to which all the marginal lakes of the Tarim belong, as also Markat, the lakes of the eastern waterway, the bed of the Lop-nor, and the deepest hollow along our levelled line.

Between these two lines of depression there exist also several others like them, but lying at right angles to them, that is they extend north and south. I mean the bajir depressions which are occupied by certain parts of the Tarim and its lakes. Setting aside Markat, which, with an absolute maximum depth of 14 m., lies higher up, we obtain in this part of the region the following maximum depths.

---

* This figure is wanting on his map; it is the mean between the two adjacent stations.

| | |
|---|---|
| Avullu-köl | 6.10 m. |
| Kara-köl | 6.52 " |
| Tajek-köl | 9.52 " |
| Arka-köl | 7.13 |
| Tschivilik-köl | 5.15 |
| Ilek | 12.55 |
| Arghan | 8.22 |
| Tarim at Jangi-uj (1896) | 8.80 |
| Kara-koschun | 5.15 |

This brings us to the consideration of the parallelogram I have mentioned. Its western side, from Tajek-köl to Tschigelik-uj, measures 81 km., or the same length as the line we surveyed. On Pl. 61 (a) *a* we have a profile of the line AB with the depths sounded. Tschigelik-uj (819 m.) lies 9 m. lower than the Tajek-köl (828 m.), but the bottom of the Tarim (5.06 m. deep) lies only 4½ m. lower than the bottom of the Tajek-köl (9.52 m.). Thus the bottom of the Tajek-köl lies half a meter lower than the bank of the Tarim at Tschigelik-uj. But as the Tajek-köl certainly possesses considerably greater depths than 9.52 m., and since the Tarim in several places north of Tschigelik-uj is shallower than it is there, we may even speak of a rise of the bed towards the south. And this becomes indeed quite certain when we take into consideration the stretch between the Tajek-köl and the Lajlik-darja, where the maximum depth at Camp XXXII amounted to 2.26 m. Thus while the difference of altitude amounts to only 5 m., the bottom of the river at the latter place is more than 2 m. higher than it is at the former. Along this considerable stretch, which embraces more than the half of the line AB, it may truly be said that the bed rises towards the south, precisely as the ground does in the Desert of Tschertschen and in the Desert of Gobi. The position will be made clear from the accompanying illustration (fig. 260), in which the surface at A lies higher than the surface at B, so that the water after filling the depression A must flow down to B, but in point of actual fact the bottom at A lies lower than the bottom at B. The absolute difference of altitude between the bottom of the Ilek (12.55 m. depth) and the bottom at Tschigelik-uj (5.06 m. depth) only amounts to 1.51 m., although the difference of altitude of the banks reaches 9 m.

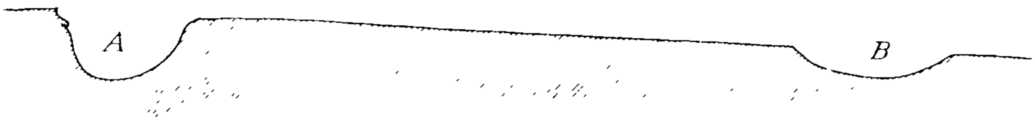

Fig. 260.

The southern side, BC, of our parallelogram is also interesting, for there we find very clearly (see Pl. 61 (a) *b* and *c*), that the bed does actually rise from west to east, although the water flows in the same direction, the reason being that Tschigelik-uj lies 3 m. higher than the level of the Kara-koschun. But the two profiles speak indeed for themselves. The four years that intervene have not been able to bring about any noteworthy change; and yet we find, as indeed was to be expected, that in the year 1900 the bed was shallower than it was in 1896.

With regard to the eastern line DC, I will refer the reader to Chapter XXII of this volume. Here the surface falls from north to south to the extent of 2.282 m. between station No. 1 and station No. 346; but between the stations No. 83 and No. 346 it rises in the same direction to the extent of 1.689 m. And if we go one step farther towards the west, that is about 14 km., we see quite clearly that the surface falls from south to north, as the blue current arrows show on Pl. 41.

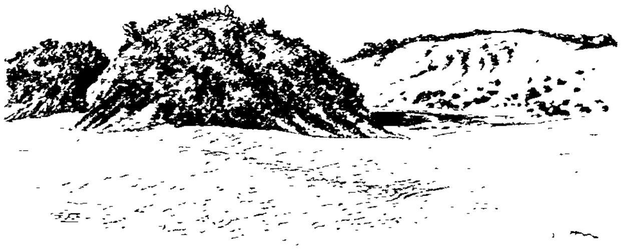

Fig. 261. DUNES FORMING INTO MOUNDS, EASTERN SHORE OF TAJEK-KOL: IN THE MIDDLE IS A SALT POOL.

The line AD in our parallelogram is particularly interesting. If the Tajek-köl has an altitude of 828 m., and if the starting-point of our levelled line at Lôu-lan has an altitude of 818.3 m., we get a fall of almost 10 m. along a distance of 117 km. The bottom of the Tajek-köl (9.52 m.) lies almost exactly at the same absolute altitude as the starting-point of our surveyed line. But while this last-named has an absolute altitude of 818.3 m., the deepest place that we sounded in the Ilek has an absolute altitude of 815.45 m., and consequently lies 3 m. lower than station No. 1 of the surveyed line and over 5 m. lower than station No. 2. Hence it is only one of the underground, sand-covered, ridges between the chains of bajirs that are now occupied by lakes, that prevents the water of the Tajek-köl, the Avullu-köl, and the Kara-köl from following the line of natural fall and flowing directly eastwards to the bed of the old Lop-nor. A breach in this ridge is all that is required to give the water a free outlet to the depression in the east. Pl. 61 (a) *c* gives a profile of the line AD, there I have also plotted the probably deepest part of the old depression. This is shown again in the profile sketch *f*, which cuts only the southern part of the Lop-nor along the line EF on Pl. 41. Between station No. 129 (814.3 m.) and the shore of the Arka-köl (827 m.) the difference of altitude amounts to 13 m. in a distance of 131 km.

The profile *d*, that is the surveyed line, is reproduced for the sake of comparison. Only every tenth station is however indicated. To the Kara-koschun I have here given its probable breadth along the meridian surveyed; on Pl. 37 the lake is rather too broad.

The sole object of the above exposition has been to set forth more fully the extraordinary horizontality of the Lop country: nor indeed is anything else to be expected in an alluvial region in which the rivers and lakes wander backwards and forwards between north and south, and thus in time completely level up the country, and level it up to such an extent that the excavating power of the wind is quite sufficient to give rise to fresh hydrographical alterations. The exceptions to the general flatness are not many. For instance, there exists a difference of 15.39 m. in elevation between the crest of the plant-bound sand-dune at Kum-tschapghan and the greatest depth in the Kara-koschun. If we also draw into our comparison the height of the dunes we measured in the Desert of Tschertschen, namely 89.5 m., and compare them with the 14.0 m. in the Markat region, we get a difference of elevation amounting to 103.5 m. But then not only do the dunes in question lie outside the area we are discussing, they are entirely a secondary phenomenon, for they owe their present position to the wind. Moreover the lake-depth which I have quoted is also due to a secondary influence, namely the wind, as we have already seen. Consequently these abnormal differences of elevation are in no respect antagonistic to the generalisation, that the surface of the Desert of Lop is inconceivably flat; and in the case of that part of it which especially interests us, we know that station No. 346 does lie not only 2.282 m. lower than station No. 1, but 1.669 m. higher than station No. 129.

All that now remains is for me to add a few words to three plates which relate to previous chapters, and which I have drawn since the chapters in question were printed. Pl. 44 a reproduces the picture of the distribution of the drift-sand in the basin of the Tarim. The green-coloured patches representing vegetation may perhaps be considered to occupy far too great an area; but I hasten to point out, that those which are tinted a lighter shade of green merely indicate ground which is of such a kind as to be capable of supporting vegetation, but which as a matter of fact over extensive areas, e. g. the triangle Kaschgar—Jarkent—Maral-baschi, carries only an extremely thin sprinkling of vegetation, and indeed it is often barren except for an occasional withered scrubby bush. Generally, the lighter tint may be taken as indicating steppe and cultivated country, and the darker tint forest.

The same remarks apply to Pl. 39, where the varying shades of colour used in depicting the sand are intended to exhibit its varying amount, which in general increases from east to west. Here we see beautifully the broad path which the branches of the Tarim have carved for themselves through the belt of drift-sand, mere fragments of which are now left between them. The belt of sand in the Desert of Lop advances transgressively across the clay desert, the northern and eastern outskirts of which are however exposed. The section that projects towards the north-east formed at some time or other a part of the bottom of the Lop-nor; similar new formations of clay sediment are taking place at the present time on the bottom of the existing Kara-koschun. The zones of schor are depicted on the southern shore of the old lake and on the corresponding shore of the new lake as well. A long way off to north and south the hard gravelly scree rises slowly up towards the Kuruk-tagh and the Astin-tagh respectively.

Pl. 40 shows the belts which are excavated by the wind and those filled up with sediment, drift-sand, and organic material, as well as the region that intervenes and which has recently been filled with water. Here we see also the most important of the old and new beds of the Tarim. A circular section illustrates the pendulum-like oscillations of the lowermost Tarim and its terminal lake.

Before we leave the Lop country I must return to a question touched upon in the beginning of this volume, namely the question of Jing-pen and Ju-jing-pen. I have said there (p. 42), that I am very much inclined to regard them as identically the same place, but go on to add, that in default of further evidence I do not feel warranted in disregarding Kosloff's observations in the same locality. I therefore considered it possible, that my Jing-pen might be identical with his Empen or rather

Jempen, while Ju-jing-pen, which I visited in 1896, may be another similar station, situated on the Kuruk-darja farther to the south-west. But since I have now had all my astronomical determinations of locality calculated by Dr. K. G. Olsson, I am in the position to deny categorically the correctness of the map which Kosloff prints in his pamphlet *Lop-nor*. Ju-jing-pen, Jing-pen, and Jimpen are one and the same place. In my map which Dr. B. Hassenstein constructed for *Petermanns Mitteilungen* this place is put at 40° 53' 30" N. lat. and 87° 43' 30" E. long. According to Olsson's calculation of my astronomical observation its position is 40° 57' 14" and 87° 49' 6". Thus on Hassenstein's map Ju-jing-pen ought to be shifted exactly ten km. towards the north-east, and Turfan-karaul on the Kontsche-darja ought to accompany it, being moved about half the distance in the same direction. The fact that Dr. Hassenstein, notwithstanding that I was only able to supply him with a few astronomical points, nevertheless hit the actual position so closely — merely with the help of my itinerary and the incomplete information he already possessed regarding that region — speaks volumes not only for his acuteness and accuracy, but also for the reliability of my measured itinerary. But he has been misled, as I was, by Kosloff's map, and has entered Kosloff's route which is twice as long as mine, and consequently he thought as I did, that there might possibly be two Chinese stations on the Kuruk-darja. In the atlas of 80 large sheets on the scale of 1: 200.000 which Dr. Hassenstein constructed of my former journey,* and which form the basis of the maps on the scale of 1: 1,000.000 published in *Petermanns Mitteilungen*, Ergänzhft 131, the region in question is shown on sheet VII. 12. On it the distance in a straight line between Jing-pen and Turfan-karaul is 28 km.; but since the reconstruction has been controlled by degree-lines and corrected, the same distance has shrunk to 20 km. According to the data I gathered during my last journey, it ought, as also appears from Pl. 40, to be 25½ km. How Kosloff managed to get this distance to work out at exactly 40 km. is difficult to understand

Finally in the light of my profiles of the Kuruk-tagh, given at the beginning of this volume, and of Dr. Ekholm's calculation of my hypsometrical observations, I will add a few words with regard to the hypsometrical relations of the eastern parts of the Kuruk-tagh which I have visited. The mean altitude of the 43 stations at which I took observations amounts to 1080.5 m. In this calculation I have however included *all* my measurements, passes and depressions as well, as also those taken on the gravelly scree that slopes down towards the lowlands of Lop. If all these are deducted, the mean altitude of the plateau upon which the eastern Kuruk-tagh stands is 1171 m. If we take the mean altitude of the Desert of Lop to be 820 m., then the difference of altitude amounts to 371 m., or very little more than the altitude of the Eiffel tower at Paris! The extreme northern terraced step of the Tibetan plateau, if we disregard the mountain-chains that are built up upon it, has a mean elevation ten times that of the Kuruk-tagh plateau.

The two highest passes that I climbed over in the Kuruk-tagh had altitudes of 1658 m. and 1535 m. respectively. Thus the altitude, 1953 m., at Tatlik-bulak, at the very threshold of the Tibetan mountains, is almost exactly 300 m. higher than the loftiest pass in the eastern Kuruk-tagh! I am however willing to concede that there are higher points in the Kuruk-tagh than those I touched: but the figures I have given above show clearly how insignificant the mountain-system is, and how little it is entitled to be delineated in the pronounced way in which it is indicated on our maps.

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* This atlas is the property of the Justus Perthes Anstalt in Gotha.

The second half of my journey through the Kuruk-tagh system brings to light a very remarkable and interesting phenomenon in hypsometry. During the stage of 17th February (see above pp. 113 ff.) we crossed over an unmistakable depression, containing in part schor, in part clay desert, with jardangs modelled with extraordinary sharpness of outline and reaching 4 to 6 m. in altitude. This depression stretches towards the north-north-east through the gap that exists there in the Kuruk-tagh, and appeared to continue towards the south-south-west, though after that it almost certainly inclines towards the south-west, and becomes merged in the old bed of the Lop-nor. Nevertheless it is probable, if one may judge from the Chinese maps, that this depression is separated from the depression of Lop by a threshold, and that it was already dry at the time when Lôu-lan flourished. In this depression I took altitudinal measurements at two places, namely 797 and 792 m. respectively. Continuing south-westwards along the base of the Kuruk-tagh until we strike the part of the 1900 route which lies north of Lôu-lan, we find there two other altitudinal measurements, taken on 27th March, namely 777 and 781 m. respectively. Now as these observations were taken in different years, it would be a strange coincidence if it were simply chance which gave rise to such a close resemblance in these altitudes, especially as the two pairs of altitudes were taken in an unmistakable elongated depression or gully. Moreover in two places beside the lowest Kuruk-darja we found an altitude of 810 m., that is exactly in the situation in which the Chinese map puts its three small lakes. Dr. Ekholm's first calculation for the altitude of Lôu-lan was 807 m.; but this, thanks to our surveyed line, we were subsequently able to correct to 818 m. Yet even when we increase by 11 the four data quoted above, and so make them 808 m. and 803 m. for the north-eastern depression, and 788 m. and 792 m. for the depression north of the proper Lop-nor, we must nevertheless acknowledge, that the indications still point to the existence here of an elongated depression deeper than any other part of East Turkestan, a depression the continuation of which to the west-north-west is plainly prescribed by the position of the Kuruk-darja. Possibly a portion of the Lop-nor ran, even in the Lôu-lan epoch, into this northernmost depression, although it is most probable that it was separated from it (see Pl. 40). On Pl. 59 I have not ventured to take this depression into account, for even though its existence is undoubted, we possess too few points of certainty to be able to determine its boundaries. The line GH on Pl. 41 is however drawn from this absolutely deepest depression of the Desert of Lop to the shore of the Kara-koschun. The mean of the four altitudes quoted above is 798 m., while the altitude of Kara-koschun is 816 m. Hence over a distance of 87 km. the desert here rises 18 m. from north to south — precisely the same relation that we obtained west of the line we surveyed.

# CHAPTER XLII.

## METHODS OF CALCULATING THE ALTITUDES ABOVE SEA-LEVEL.

By D:r **NILS EKHOLM.**

### I.

The only means of finding the altitudes above sea-level in the interior of the Asian continent, where it has hitherto been impossible to determine the altitude of any point by levelling from the sea, is by barometrical measurement. The precision of this method is not, of course, comparable with that of levelling. But as the barometrical observations made by Dr. Hedin are very accurate, having been made by good holosteric barometers and a Richard barograph and controlled by daily hypsometrical observations taken by the excellent boiling thermometers of Fuess in Berlin, the method will in this case certainly furnish the best possible results. A more detailed description will be given in the meteorological part of this work, and I shall here only give a sketch of the main points.

Owing to the kind assistance of the late Director H. Wild and of the present Director M. Rykatchew of the Central Physical Observatory of St. Petersburg and that of the former and present Secretaries of the Meteorological Office of London, Dr. R. H. Scott and Dr. W. N. Shaw, I have received series of meteorological observations from several stations in Russian Asia and in India. The altitude of those stations above sea-level is known partly by means of levelling from the sea, partly by means of daily barometrical observations taken during several years. In most cases the error of those altitudes probably does not exceed one or two meters, and in no case 10 meters.

Now by means of a barometric formula and tables calculated from it, as explained in the meteorological part (vol. V), the average barometrical pressure at altitudes of 800, 1000, 1400 and 3000 meters in the vertical line of those stations was calculated for every month, that Dr. Hedin was travelling in Central Asia. Then isobaric maps were constructed by means of those average pressures and the isobars were extended over the unknown intervening space in the manner that seemed to be most probable. From these isobaric maps the barometric pressure at one of the the altitudes indicated was taken for every point at which Dr. Hedin made observations during the month for which the map was constructed; and by comparing this pressure with that observed by Dr. Hedin, the altitude of his station was calculated. In some cases, where a meteorological station of known altitude was situated not too far from Dr. Hedin's station I found it more convenient to calculate the altitude by comparing directly the simultaneous meteorological observations at the two stations. Thus the altitudes of most stations of Pamir have been calculated from the meteorological observations made at Margelan, Osch or Pamirski Post and those of some stations in Tibet from observations made at Leh. But this method is only advantageous when the two stations are so near together that the barometric pressures at those stations vary simultaneously in a similar manner.

Also as I found it nearly impossible to draw distinct isobars for the altitude of 3000 meters in Tibet, it seemed more convenient to calculate the altitudes from the average monthly barometric pressures at Leh and in some cases at Darjeeling, than from the isobars constructed for the altitude of 3000 meters.

As the barometric pressure varies not only with the height above sea-level but also with the weather, the error of the altitude, when calculated from only one or a few observations by means of the monthly average pressure at a known altitude in the same vertical line, may accidentally amount to 50 or 100 meters and even more. In order that the explorer might obtain results in which the error does not exceed 10 meters, it would be necessary for him to stay weeks or even months at every place, the altitude of which is to be determined, and to make daily observations during the whole of that time. In this case the average pressure found would give the desired result by means of the method of calculation explained above.

But as the explorer obviously could not stay so long at each place, Dr. Hedin, during his last journey, established several permanent stations, where the meteorological observations were obtained by means of self-recording instruments and with the aid of his attendants. The most important of those stations are: the headquarters at *Jangi-köl* (40° 52′ Lat. N., 86° 51′ Long. E. from Greenwich, 881 meters above sea-level), where tri-daily observations and continuous records were taken from the 7th Dec. 1899 to the 19th May 1900; *Mandarlik* (37° 47′ Lat. N., 90° 47′ Long. E. fr. Gr., 3437 meters above sea-level) ditto from the 13th July to the 3rd Aug. 1900; *Kasch-otak* (38° 3′ Lat. N., 90° 47′ Long. E. fr. Gr., 2916 meters above sea-level) ditto from the 3rd to the 20th Aug. 1900; *Temirlik* (38° 11′ Lat. N., 90° 19′ Long. E. fr. Gr., 2961 meters above sea-level) ditto from the 21st Aug. to the 20th Dec. 1900; and *Tscharklik* (39° 2′ Lat. N., 88° 0′ Long. E. fr. Gr., 925 meters above sea-level) ditto from the 1st Jan. to the 17th May 1901.

The altitudes above sea-level given above for those stations have been calculated by means of the monthly isobaric maps in the manner explained. Then the altitudes of Dr. Hedin's stations during the journeys he was simultaneously making have been calculated by comparing the observations taken by himself and those taken at the permanent station.

In this way the error due to accidental variations of the barometric pressure, caused by weather changes, is much diminished, and so much the more, the less the distance is between the two stations. But as the distance has in some cases been considerable, the error of the calculated altitudes has amounted accidentally to 30 meters and even more, as shown by the methods of calculating differences of altitudes, that I will now explain.

## II.

In the first place it may be remarked, that, all stations situated on the shore of a lake having the same altitude above sea-level, all the barometric observations taken at those stations may be combined into an average, from which the common altitude may be calculated. Also, if those stations are not all at the same level, but the altitude of each above the level of the lake has been measured or estimated, the barometric pressures observed at the altitudes calculated from them may be reduced to the level of the lake and then averaged, in order to find the most reliable value of the altitude of the lake above sea-level, and then the altitudes of the stations above sea-level are easily obtained.

The same method is applicable, if the differences of the altitudes of the stations have been found by actual levelment.

Further, if the stations are situated along a river, the altitudes will necessarily diminish continuously in the direction of the flow. Hence if the calculated altitudes are taken as ordinates and the corresponding length of the river, measured from a fixed origin, as abscissæ in a system of rectangular coordinates, then the curve drawn through the upper points of the ordinates must necessarily show a uniform slope in the direction of flow. If this be not the case, the curve must be equalised by a proper method in order to satisfy this essential condition. Such an equalisation I have effected simply by joining to averages groups of ten or more ordinates and corresponding abscissæ and then drawing a new curve by means of the average coordinates.

In the case of the river Tarim it was possible to use a more exact method. For Dr. Hedin has made a great many hydrometrical measurements along the course of that river, and in each section thus measured the slope may be calculated by means of a known empirical formula. I have used the following, due to Basin*

$$s = \frac{V_m^2}{r}\left(0.00028 + \frac{0.00035}{r}\right) \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

where $s$ denotes the slope, i. e. the difference of altitude in the unit of length, $V_m$ the mean velocity of the river,** and $r$ the mean radius or mean hydraulic depth, defined by the formula

$$r = \frac{A}{p} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

$A$ denoting the area of the total section of the river and $p$ the »wet perimeter» of the section, i. e. the length of the curve $AO_1P_1O_2P_2O_3 \ldots O_{n-2}O_{n-1} \ldots B$ formed by the section between the vertical plane and the bottom of the river.*** The value of $p$ was found by measurement on the sketches drawn from Dr. Hedin's hydrometrical data.

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* See for instance G. Tolkmitt, *Grundlagen der Wasserbaukunst*, p. 104—107, Berlin 1898.

** Cfr Sven Hedin, *Scientific Results of a Journey in Central Asia 1899—1902*, vol. I, p. 30. Stockholm 1904.

*** Cfr Sven Hedin, *loc. cit.*, p. 30, fig. 34.

In this way the slope $s$ was calculated at each point of hydrometrical measurement. Then the length of the river curve was measured on the charts between all those points, and the parts occupied by lakes or still water, i. e. the horizontal parts, where the slope was equal to zero, were measured separately.

Now, let $A_1$, $A_2$, $A_3$, . . . $A_{n-1}$, $A_n$ be a series of consecutive points of measurement, let $a_{1,2}$, $a_{2,3}$, . . . $a_{n-1,n}$ be the distances between them, and let $s_1$, $s_2$, . . . $s_{n-1}$, $s_n$ be the slopes at those points. Then I have supposed the difference of altitude between $A_1$ and $A_2$ to be $\frac{1}{2}(s_1+s_2)\,a_{1,2}$, that between $A_2$ and $A_3$ to be $\frac{1}{2}(s_2+s_3)\,a_{2,3}$, . . . , that between $A_{n-1}$ and $A_n$ to be $\frac{1}{2}(s_{n-1}+s_n)a_{n-1,n}$, and consequently the difference of altitude between $A_1$ and $A_n$ will be the sum of all these expressions. In this calculation all the horizontal parts ought to be excluded and treated separately.

After the numerical calculation was performed, a vertical section of the river was constructed, with the river lengths as abscissæ and the altitudes of $A_1$, $A_2$ . . . . $A_{n-1}$ above the lowest point, $A_n$ say, as ordinates. The points $A_1$, $A_2$, . . . $A_n$ were then joined by a curve, in which all horizontal parts were drawn as straight lines parallel to the axis of the abscissæ, and the altitudes of all intermediate points were taken from the figure.

The work was divided into two parts, the one from Lajlik to Jangi-köl, the other from Jangi-köl to Kara-koschun. The result is given in the following tables.

## Table I.

## The Tarim river from Lajlik to Jangi-köl.

| Name of station | Month and day 1899 | | Lat. N | | Long. E from Greenwich. | | $s \cdot 10^3$ | Distance along the river from Jangi-köl in kilometers | Altitude above Jangi-köl in meters | Altitude above sea-level in meters |
|---|---|---|---|---|---|---|---|---|---|---|
| Lajlik | Sept. | 10—17 | 38 | 59′ | 77° | 34′ | — | 1394.4 | 292 | 1173 |
| Ghasanglik | | 17 | 39 | 3 | 77 | 35 | — | 1381.2 | 288 | 1169 |
| Bisch-köl | | 18 | 39 | 8 | 77 | 43 | 0.267 | 1363.4 | 283 | 1164 |
| Schäschkak | | 19 | 39 | 10 | 77 | 47 | 0.090 | 1350.4 | 281 | 1162 |
| At-pangsa | | 21 | 39 | 13 | 77 | 51 | 0.110 | 1331.5 | 279 | 1160 |
| Toghluk (Schakal-otak) | | 22 | 39 | 18 | 77 | 54 | 0.059 | 1315.3 | 278 | 1159 |
| Kötäklik-darja | | 23 | 39 | 19 | 77 | 59 | 0.380 | 1305.8 | 276 | 1157 |
| Lepscheme (Töländä) | | 23 | 39 | 19 | 78 | 3 | 0.036 | 1300.8 | 275 | 1156 |
| Karul-dung | | 24 | 39 | 22 | 78 | 7 | — | 1291.1 | 274 | 1155 |
| Kum-atschal | | 25 | 39 | 22 | 78 | 9 | 0.234 | 1286.7 | 273 | 1154 |
| Läschlik | | 27 | 39 | 23 | 78 | 20 | 0.452 | 1266.8 | 267 | 1148 |
| Jalghus-jigde | | 28 | 39 | 29 | 78 | 25 | 0.246 | 1245.9 | 259 | 1140 |
| Kijik-tele-tschöl | | 29 | 39 | 31 | 78 | 31 | 0.181 | 1227.0 | 256 | 1137 |
| Haradighan-kötek | | 30 | 39 | 36 | 78 | 36 | 0.017 | 1210.0 | 248 | 1129 |
| Kuruk-asti | Oct. | 1 | 39 | 38 | 78 | 43 | 0.154 | 1193.0 | 241 | 1122 |

**Table I** (continued).

| Name of station | Month and day 1899 | | Lat. N | | Long. E from Greenwich. | | $s\ 10^3$ | Distance along the river from Jangi-köl in kilometres | Altitude above Jangi-köl in meters | Altitude above sea-level in meters |
|---|---|---|---|---|---|---|---|---|---|---|
| Jigde-östäng | Oct. | 4 | 39° | 38′ | 78° | 45′ | — | 1191.0 | 240 | 1121 |
| Jughan-balik | | 4 | 39 | 37 | 78 | 51 | | 1184.9 | 240 | 1121 |
| Sorun | | 5 | 39 | 38 | 78 | 56 | 0.054 | 1157.7 | 239 | 1120 |
| More | | 8 | 39 | 40 | 79 | 1 | 0.452 | 1144.7 | 231 | 1112 |
| Milka | | 9 | 39 | 42 | 79 | 7 | 0.355 | 1126.0 | 227 | 1108 |
| Ak-satma | | 10 | 39 | 42 | 79 | 13 | 0.227 | 1103.7 | 220 | 1101 |
| Dugha-dschaji | | 11 | 39 | 43 | 79 | 14 | 0.007 | 1095.2 | 220 | 1101 |
| Tugha-pangsa-baschi | | 12 | 39 | 42 | 79 | 20 | 0.501 | 1075.2 | 215 | 1096 |
| Toghri | | 13 | 39 | 45 | 79 | 22 | 0.251 | 1053.0 | 206 | 1087 |
| Jigdelik | | 14 | 39 | 47 | 79 | 30 | | 1034.3 | 201 | 1082 |
| Islik | | 15 | 39 | 49 | 79 | 36 | 0.425 | 1012.0 | 194 | 1075 |
| Kujluschning-baschi | | 16 | 39 | 55 | 79 | 38 | 0.602 | 990.6 | 175 | 1056 |
| Jar-kotan | | 17 | 40 | 2 | 79 | 44 | 0.303 | 964.3 | 170 | 1051 |
| Käptär-asti (Atschi-dung) | | 18 | 40 | 5 | 79 | 48 | 0.152 | 953.5 | 167 | 1048 |
| Jäkänlik-köl | | 19 | 40 | 7 | 79 | 54 | — | 939.7 | 165 | 1046 |
| Kalmak-kum | | 20 | 40 | 12 | 80 | 2 | 0.017 | 921.0 | 165 | 1046 |
| Tscholak-dung | | 21 | 40 | 14 | 80 | 11 | 0.202 | 901.5 | 162 | 1043 |
| Usun-jurt | | 22 | 40 | 22 | 80 | 17 | 0.109 | 879.8 | 159 | 1040 |
| Matan | | 23 | 40 | 24 | 80 | 19 | 0.087 | 869.4 | 158 | 1039 |
| Hangetlik | | 25 | 40 | 27 | 80 | 26 | 0.256 | 851.4 | 155 | 1036 |
| Jesi-köl | | 26 | 40 | 28 | 80 | 36 | 0.134 | 830.5 | 152 | 1033 |
| Mouth of Ak-su-darja | | 27 | 40 | 29 | 80 | 41 | — | 822.2 | 150 | 1031 |
| Aral | | 29 | 40 | 31 | 80 | 47 | — | 807.0 | 148 | 1029 |
| Kan-begi | | 30 | 40 | 32 | 80 | 59 | — | 789.7 | 144 | 1025 |
| Modsche-toghrak | | 31 | 40 | 32 | 81 | 2 | — | 785.5 | 143 | 1024 |
| Busuk | Nov. | 1 | 40 | 35 | 81 | 3 | 0.229 | 780.5 | 142 | 1022 |
| Läschlik | | 1 | 40 | 40 | 81 | 10 | — | 766.0 | 138 | 1020 |
| Ala-kunglek | | 2 | 40 | 43 | 81 | 35 | — | 728.5 | 129 | 1010 |
| Tälpäk | | 3 | 40 | 50 | 81 | 45 | — | 691.5 | 115 | 996 |
| Intschkä | | 4 | 40 | 51 | 81 | 54 | 0.410 | 667.3 | 104 | 985 |
| Bostan | | 5 | 40 | 56 | 82 | 8 | — | 636.2 | 91 | 972 |
| Kara-daschi | | 6 | 41 | 0 | 82 | 20 | — | 607.9 | 84 | 965 |
| Peres (Tschimen) | | 7 | 41 | 2 | 82 | 31 | 0.181 | 587.6 | 81 | 962 |
| Arik-aghsi | | 10 | 40 | 58 | 82 | 45 | — | 559.1 | 76 | 957 |
| Tugha-baschi | | 11 | 40 | 57 | 82 | 55 | — | 541.6 | 73 | 954 |
| Sor-sure | | 12 | 40 | 58 | 83 | 2 | — | 524.1 | 70 | 951 |
| Kök-tschol | | 13 | 41 | 1 | 83 | 11 | — | 500.1 | 66 | 947 |
| Tupe-teschdi | | 14 | 41 | 1 | 83 | 25 | 0.116 | 469.9 | 62 | 943 |
| Kade-dung | | 15 | 41 | 0 | 83 | 32 | — | 452.7 | 61 | 942 |

**Table 1** (ended).

| Name of station | Month and day 1899 | Lat N | Long E from Greenwich | $s \; 10^3$ | Distance along the river from Jangi-köl in kilometers | Altitude above Jangi-köl in meters | Altitude above sea-level in meters |
|---|---|---|---|---|---|---|---|
| Sarik-buja | Nov. 16 | 40° 58′ | 83 45′ | — | 430.8 | 60 | 941 |
| Kitschik-hasanak | 17 | 40 58 | 83 52 | — | 415.6 | 59 | 940 |
| Tschong-aralning-toghrighi | 18 | 40 55 | 84 4 | — | 396.9 | 58 | 939 |
| Koral-dung | 19 | 40 55 | 84 5 | 0.055 | 395.8 | 58 | 939 |
| Kakte | 19 | 40 55 | 84 14 | — | 376.7 | 57 | 938 |
| Kätschik | 20 | 40 54 | 84 24 | — | 364.2 | 56 | 937 |
| Kätschkin-aghis | 21 | 40 48 | 84 32 | — | 337.0 | 54 | 935 |
| Unnamed camp | 22 | 40 42 | 84 46 | — | 310.8 | 50 | 931 |
| Unnamed camp | 23 | 40 46 | 84 56 | — | 288.1 | 46 | 927 |
| Sadik-bajning-angi | 24 | 40 46 | 84 57 | 0.164 | 284.0 | 46 | 927 |
| Kargha-jakti | 24 | 40 45 | 85 5 | — | 265.9 | 42 | 923 |
| Tokus-kum | 25 | 40 43 | 85 17 | — | 239.2 | 39 | 920 |
| Al-katik-tscheke | 26 | 40 43 | 85 20 | 0.117 | 232.3 | 38 | 919 |
| Busrugvar | 27 | 40 42 | 85 28 | — | 207.1 | 35 | 916 |
| Kum-tscheke (Siva) | » 28 | 40 45 | 85 33 | 0.105 | 186.6 | 33 | 914 |
| Kurugen-ugen | 29 | 40 49 | 85 39 | — | 164.1 | 31 | 912 |
| Ait-öttögön | 30 | 40 51 | 85 52 | — | 139.8 | 29 | 910 |
| Unnamed camp | Dec. 1 | 40 55 | 86 1 | — | 123.8 | 27 | 908 |
| Ilek | 2 | 41 2 | 86 11 | — | 97.0 | 22 | 903 |
| Momuni-ottogho | 3 | 41 3 | 86 23 | — | 70.4 | 16 | 897 |
| Karaul | 4 | 41 4 | 86 32 | 0.222 | 54.3 | 12 | 893 |
| Teis-köl | 6 | 40 57 | 86 42 | — | 24.7 | 5 | 886 |
| Jangi-köl | 7 | 40 52 | 86 51 | — | 0.0 | 0 | 881 |

Table I gives the result of the calculation of the part from Lajlik to Jangi-köl. Its contents are fully explained by the headings. In the last column we find the altitudes of the stations above sea-level. Of these only that of Jangi-köl is determined directly from the barometrical observations made at that station; all the other altitudes have been found by adding to the altitude of Jangi-köl the numbers of the last column but one. Now it is important to get some control over this result. For this purpose I have used the meteorological observations taken during the months September, October and November, and in the following way. The barometric observations during September were reduced to the altitude of Lajlik by means of the differences of altitude given in table I; the barometric observations during October were in a similar manner reduced to the altitude of Haradigan-kötek, and the barometric observations during November to the altitude of Modschi-toghrak, and the average pressure calculated for each month. Also the mean temperature of the air was calculated and the average pressure at the altitude of 800 meters above sea-level was taken from the isobaric maps for these months.

The result was as follows:

### 10th—30th September 1899.

Mean temperature at Lajlik . . . . . . . . . . . . . . . . . . . . . 17.°3 Cels.
Mean barometric pressure at Lajlik . . . . . . . . . . . . . . . . . . 662.8 mm.
Mean barometric pressure at an altitude of 800 meters above sea-level in
the vertical line of Lajlik . . . . . . . . . . . . . . . . . . . . . 693.3 »

This gives by means of the barometric formula as the altitude above sea-level of Lajlik 1191 meters, whereas table I by means of the altitude of Jangi-köl has given 1173 meters, thus a difference of 18 meters. But as the value 1191 was calculated only by means of observations during 2/3 of September, it is not quite reliable, and the value 1173 is preferable.

### October 1899.

Mean temperature at Haradigan-kötek . . . . . . . . . . . . . . . 10.°3 Cels.
Mean barometric pressure at Haradigan-kötek . . . . . . . . . . . . 669.7 mm.
Mean barometric pressure at an altitude of 800 meters above sea-level in
the vertical line of Haradigan-kötek . . . . . . . . . . . . . . . 697.0

From this we find by means of the barometric formula the altitude of Haradigan-kötek above sea-level to be 1129 meters, exactly equal to the value found from the hydrometrical data as shown in table I.

### November 1899.

Mean temperature at Modschi-toghrak . . . . . . . . . . . . . . . 0.°8 Cels.
Mean barometric pressure at Modschi-toghrak . . . . . . . . . . . . 680.0 mm.
Mean barometric pressure at an altitude of 800 meters above sea-level in
the vertical line of Modschi-toghrak . . . . . . . . . . . . . . . 699.0

from which the altitude above sea-level of Modschi-toghrak is found to be 1020 meters, whereas table I gives 1024 meters, thus a difference of only 4 meters.

From these results we may conclude that the values of the altitudes given in table I are so nearly exact that no further correction is needed.

The calculation of the altitudes between Jangi-köl and Kara-koschun presented more difficulty. The slopes of the river in its lower course seem to be rather unequal, with currents and still water alternating. Most of Dr. Hedin's hydrometrical observations have probably been executed in parts in which the current ran swiftest, and consequently do not give the average slope of the river, but a greater slope than the true slope. In the following table I give the result of the calculation of the difference of altitude between Jangi-köl and Kum-tschapghan. In this table the lengths corresponding to the slopes $s_1, s_2, \ldots s_{n-1}, s_n$ are $\frac{a_{1,2}}{2}, \frac{a_{1,2}+a_{2,3}}{2}, \ldots \frac{a_{n-2,n-1}+a_{n-1,n}}{2}, \frac{a_{n-2,n}}{2}$, which, when each slope is multiplied by its corresponding length gives a difference of altitude identical with that obtained by the above method of calculation.

## Table 2.

## The Tarim river (western branch) from Jangi-köl to Kum-tschapghan.

| Hydrometrical station | Month and day 1900 | $s\ 10^3$ | Length in kilometers along the river | Difference of altitude in meters | Corrected difference of altitude in meters |
|---|---|---|---|---|---|
| Jangi-köl . . . . . . . . . | May 16 | 0.233 | 27.3 | 6.4 | 4.0 |
| Kirtschin-tarim . . . . . . | 21 | 0.829 | 47.5 | 39.4 | 24.7 |
| Still water . . . . . . . . | — | 0.000 | 29.6 | 0.0 | 0.0 |
| Tarim . . . . . . . . . . | May 28 | 0.225 | 88.5 | 19.9 | 12.5 |
| Still water . . . . . . . . | 30 | 0.000 | 16.2 | 0.0 | 0.0 |
| Tarim . . . . . . . . . . | June 1 | 0.173 | 48.35 | 8.7 | 5.5 |
| Tarim at Ajagh-arghan . | 4 | 0.082 | 17.75 | 1.5 | 1.0 |
| Almontschuk-tarim . . . . | " 5 | 0.243 | 54.65 | 13.3 | 8.3 |
| Schirge-tschapghan . . . . | 10 | 0.124 | 65.2 | 8.0 | 5.0 |
| Tschigilik-uj . . . . . . . | " 12 | 0.065 | 28.25 | 1.8 | 1.1 |
| Still water . . . . . . . . | — | 0.000 | 8.1 | 0.0 | 0.0 |
|  | 1901 |  |  |  |  |
| Jurt-tschapghan . . . . . . | April 3 and 13<br>June 25 | 0.047 | 61.1 | 2.9 | 1.8 |
| Kum-tschapghan . . . . . | April 10 | 0.021 | 3.5 | 0.1 | 0.1 |
| Total | — | — | 496.0 | 102.0 | 64.0 |

Thus according to the hydrometrical data Kara-koschun would be 102.0 meters lower than Jangi-köl. But this is no doubt too much. For by means of 136 meteorological observations made by Dr. Hedin in the Tarim delta at Kara-koschun and its environs and of simultaneous observations made at the permanent stations Jangi-köl and Tscharklik, the probable altitude of Kara-koschun above sea-level appears to be 816 meters. Now the altitude of Jangi-köl being 881 meters, and supposing Kum-tschapghan to be 1 meter above Kara-koschun, the difference of altitude between Jangi-köl and Kum-tschapghan ought to be 64 meters. For this reason I have reduced all differences of altitude in the above table in the rate $\frac{64}{102}$ and thus found the corrected numbers given in the last column, which I consider as the most probable.

Now the length of the river was measured between all stations from Jangi-köl to Kum-tschapghan and a curve drawn as explained above, with the lengths as abscissæ and the altitudes above Kum-tschapghan as ordinates. and from this construction the following table was obtained.

### Table 3.

## The Tarim river (western branch) from Jangi-köl to Kum-tschapghan.

| Name of station | | Month and day 1900. | Lat. N | Long. E. from Greenwich | Distance along the river from Jangi-kol in kilometres | Altitude above sea-level in metres. |
|---|---|---|---|---|---|---|
| Camp | I | May 19 | 40° 47′ | 86° 59′ | 15.5 | 878 |
| » | II | » 20 | 40 44 | 87 2 | 22.3 | 877 |
| » | III | 21 | 40 44 | 87 4 | 28.7 | 875 |
| » | IV | 22 | 40 41 | 87 10 | 44.1 | 868 |
| » | V, Bobane-uktusu | 23 | 40 37 | 87 23 | 65.7 | 857 |
| » | VI, Jäkenlik | 24 | 40 36 | 87 38 | 74.8 | 852 |
| » | VII | 27 | 40 30 | 87 41 | 104.4 | 852 |
| » | VIII | 28 | 40 27 | 87 50 | 143.7 | 846 |
| | IX, Kona-daghilek | 29 | 40 26 | 88 1 | 171.4 | 843 |
| » | X, Satovaldi-köl | 30 | 40 18 | 88 5 | 192.9 | 840 |
| » | XI | 31 | 40 12 | 88 8 | 209.1 | 840 |
| | XII | June 1 | 40 8 | 88 15 | 251.2 | 834 |
| » | XIII, Ajagh-arghan | 2 | 40 9 | 88 20 | 263.7 | 833 |
| » | XIV, Almontschuk | 5 | 40 2 | 88 21 | 286.7 | 832 |
| » | XV | 6 | 39 54 | 88 23 | 322.9 | 826 |
| » | XVI | 8 | 39 53 | 88 21 | 333.1 | 825 |
| Schirge-tschapghan | | 10 | 39 45 | 88 23 | 373.0 | 822 |
| Camp | XVII, Karghalik-otak | 11 | 39 42 | 88 24 | 383.5 | 822 |
| » | XVIII, Tschigilik-uj | 11 | 39 32 | 88 23 | 417.1 | 819 |
| Tokus-atan | | 19 | 39 29 | 88 24 | 423.3 | 819 |
| Badschit-tschantschdi | | 20 | 39 28 | 88 44 | 431.4 | 818 |
| Jurt-tschapghan | | 21 | 39 30 | 88 56 | 492.5 | 817 |
| Kum-tschapghan | | 30 | 39 30 | 89 4 | 496.0 | 817 |

But Dr. Hedin travelled also along the eastern branch of the Tarim delta from Tokus-tarim up to Jangi-köl and did there a considerable amount of hydrometrical work, which enables us to get another determination of the difference of altitude between Jangi-köl and Tokus-tarim or Schirge-Tschapghan, which is very nearly at the same level as Tokus-tarim. The result is given in table 4 (next page).

Now the altitude of Jangi-köl above sea-level being 881 metres, we get for the altitude of Schirge-tschapghan (Tokus-tarim) 823.3, which agrees so nearly with the value 822 metres, obtained above, that no further correction is needed.

Finally in Tables 5 and 6, I give the data of the stations from which the altitudes above sea-level of Kara-koschun has been calculated by means of the meteorological observations, as described above, and the data of the stations from Tokus-tarim to Jangi-köl.

## Table 4.

## The Tarim river (eastern branch) from Tokus-tarim to Jangi-köl.

| Hydrometrical station. | Month and day 1900. | $s \cdot 10^3$ | Length along the river in kilometers | | Difference of altitude in meters | altitude above sea-level in metres. |
|---|---|---|---|---|---|---|
| Tokus-tarim | April 16 | 0.0832 | | | | 822 |
| | | | flowing | 16.7 | 1.4 | |
| | | | still | 24.7 | 0.0 | |
| Camp XXXII, Lajlik-darja | 21 | 0.0716 | | | | 823.4 |
| | | | flowing | 36.4 | 2.6 | |
| Ilek at Kum-tscheke | 24 | 0.0515 | | | | 826 |
| | | | still | 25.2 | 0.0 | |
| | | | flowing | 12.6 | 0.9 | |
| Islamni-uji Ilek | 24 | 0.0989 | | | | 826.9 |
| | | | flowing | 3.4 | 0.2 | |
| C. XXXV, Ilek near Barat-kulni-kölli | 25 | 0.0472 | | | | 827.1 |
| | | | flowing | 50.2 | 2.6 | |
| | | | still | 29.7 | 0.0 | |
| Kuntschekisch | May 1 | 0.0754 | | | | 829.7 |
| | | | flowing | 9.0 | 0.5 | |
| Kuntschekisch Sekitma | 2 | 0.0378 | | | | 830.2 |
| | | | flowing | 75.0 | 7.2 | |
| Camp XLII, Kuntschekisch | 4 | 0.153 | | | | 837.4 |
| | | | flowing | 26.5 | 2.8 | |
| Kuntschekisch above Kalmak-ottogo | 5 | 0.0553 | | | | 840.2 |
| | | | flowing | 1.1 | 0.2 | |
| Kuntschekisch above Kalmak-ottogo | 5 | 0.228 | | | | 840.4 |
| | | | flowing | 22.6 | 11.9 | |
| | | | still | 25.2 | 0.0 | |
| Kepek-uj | - | — | | | | 852.3 |
| | | | flowing | 82.3 | 27.4* | |
| Kirtschin-tarim | 21 | 0.829 | | | | — |
| Jangi-köl | 16 | 0.233 | — | | — | — |
| Total | — | — | | 440.6 | 57.7 | |

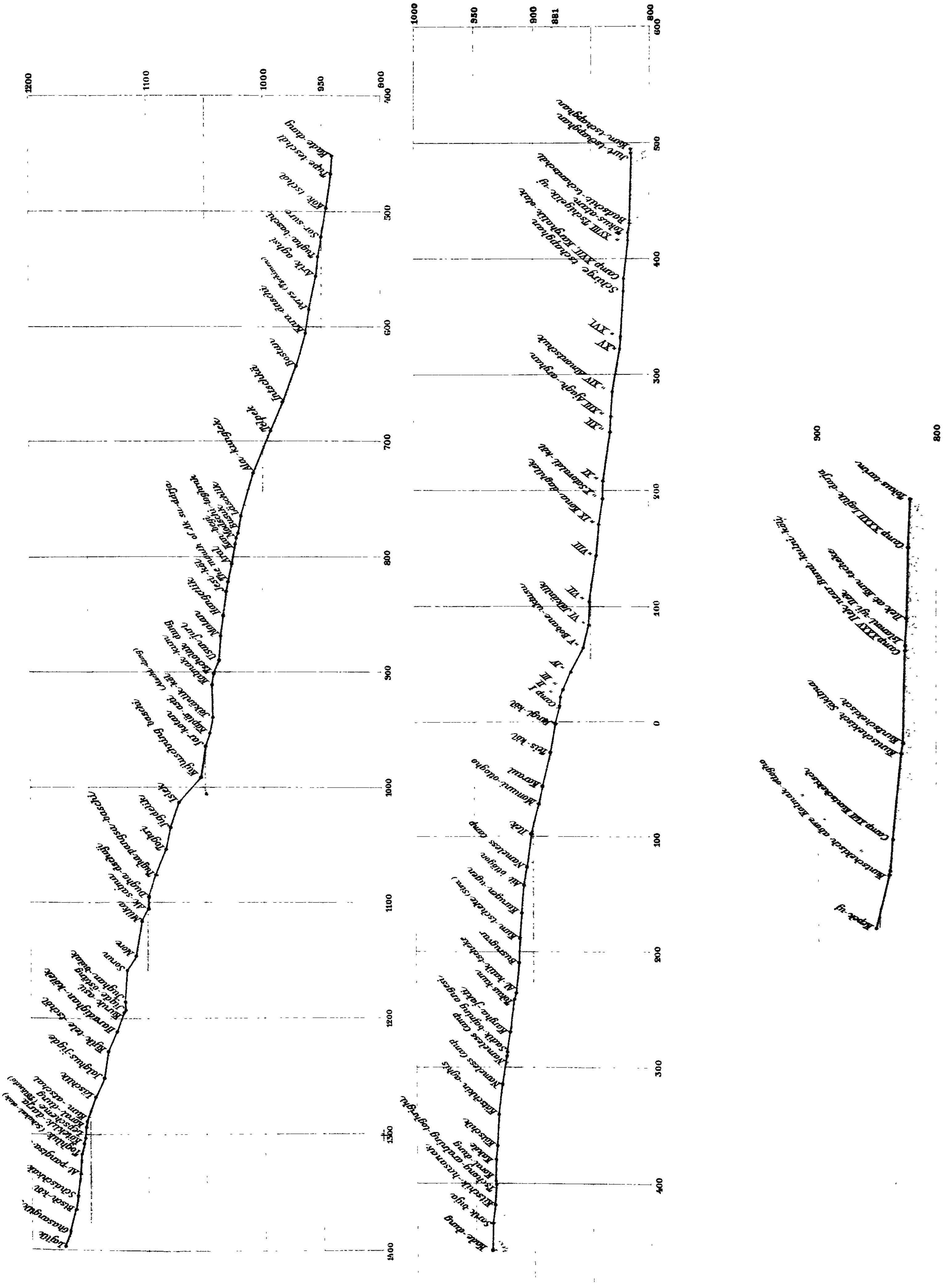
## Table 5

## The Tarim delta, environs of Kara-koschun.

| Name of station | Month and day 1900 | Lat N | Long E from Greenwich | Altitude above (+) or below (—) Kara koschun in meters measured or estimated. | Altitude above sea-level in meters. |
|---|---|---|---|---|---|
| Camp XVI. | March 28—29 | 40° 32′ | 89° 51′ | + 2 | 818 |
| At the lake | April 1 | 40 0 | 89 30 | − 1 | 815 |
| Camp XX, at a lake | 1—2 | 40 0 | 89 25 | − 1 | 815 |
| Camp XXI | 2—5 | 39 51 | 89 24 | − 1 | 815 |
| The first river arm | 5 | 39 44 | 89 18 | 0 | 816 |
| Camp XXII | March 5—6 | 39 37′ | 89 11 | 0 | 816 |

* The calculation gives 43.7, which has been reduced in the ratio $\frac{64}{102}$, as the slopes for Kirtschin-tarim and Jangi-köl have been taken from Table 2.

Dr Sven Hedin, Journey in Central Asia 1899-1902.



Horizontal Scale - 1:4,000,000. Vertical Scale - 1:4,000.

Fotolit. Gen. Stab. Litt. Anst. Stockh.

**Table 5** (contined).

| Name of station. | Month and day 1900 | Lat N | Long E from Greenwich | Altitude above (+) or below (—) Kara-koschun in meters measured or estimated. | Altitude above sea-level. in meters. |
|---|---|---|---|---|---|
| At the passage of a river arm | April 6 | 39 33′ | 89 6′ | 0 | 816 |
| Camp XXIII | » 6—7 | 39 33 | 89 2 | + 3 | 819 |
| Kum-tschapghan | Apr. 7—8, 9—12 | 39 30 | 89 4 | + 1 | 817 |
| Half-way | April 8 | 39 32 | 89 8 | 0 | 816 |
| Camp XXV, Ajagh-köl | » 8 | 39 34 | 89 12 | 0 | 816 |
| Avug-köl | » 11 | — | — | 0 | 816 |
| Jol-tschapghan | » 12 | 39 31 | 89 2 | + 1 | 817 |
| Jurt-tschapghan | 12—14 | 39 30 | 88 56 | + 1 | 817 |
| Camp XXVII, Jangi-jer | 14—15 | 39 38 | 88 43 | + 4 | 820 |
|  | 1901 |  |  |  |  |
| Camp CLIX = Camp XVI above | March 4—10 | 40 32 | 89 51 | + 2 | 818 |
| Camp CLX | 10—12 | 40 26 | 89 52 | + 2 | 818 |
| Half-way | 12 | 49 23 | 89 53 | + 3 | 819 |
| Camp CLXI | » 12—13 | 40 20 | 89 54 | 0 | 816 |
| Half-way | 13 | 40 17 | 89 54 | 0 | 816 |
| Camp CLXII | » 13—14 | 40 14 | 89 54 | + 2 | 818 |
| Half-way | 14 | 40 10 | 89 54 | + 3 | 819 |
| Camp CLXIII | » 14—15 | 40 7 | 89 53 | + 3 | 819 |
| Half-way | » 15 | 40 3 | 89 51 | + 3 | 819 |
| Camp CLXIV | 15—16 | 39 59 | 89 49 | + 3 | 819 |
| Half-way | 16 | 39 55 | 89 48 | + 1 | 817 |
| Camp CLXV | 16—17 | 39 52 | 89 48 | + 1 | 817 |
| Camp CLXVI | » 17—20 | 39 50 | 89 44 | 0 | 816 |
| Half-way | 20 | 39 50 | 89 39 | — 1 | 815 |
| Camp CLXVII | » 20—21 | 39 50 | 89 33 | — 1 | 815 |
| Half-way | » 21 | 39 48 | 89 28 | — 1 | 815 |
| Camp CLXVIII | » 21—22 | 39 47 | 89 23 | — 1 | 815 |
| Half-way | 22 | 39 50 | 89 28 | — 1 | 815 |
| Camp CLXIX | 22—23 | 39 52 | 89 34 | — 1 | 815 |
| Half-way | » 23 | 39 51 | 89 35 | — 1 | 815 |
| Camp CLXX | 23—26 | 39 51 | 89 36 | — 1 | 815 |
| Half-way | » 26 | 39 56 | 89 38 | — 1 | 815 |
| Camp CLXXI | 26—27 | 40 2 | 89 41 | — 1 | 815 |
| Half-way | » 27 | 40 1 | 89 36 | — 1 | 815 |
| Camp CLXXII | 27—28 | 40 0 | 89 32 | — 1 | 815 |
| Half-way | 28 | 40 0 | 89 30 | — 1 | 815 |
| Camp CLXXIII | 28—29 | 39 59 | 89 27 | — 1 | 815 |

**Table 5** (ended).

| Name of station. | Month and day 1900 | Lat N. | Long E from Greenwich | Altitude above (+) or below (—) Kara-koschun in meters measured or estimated | Altitude above sea-level in meters |
|---|---|---|---|---|---|
| Camp CLXXIV . . . | March 29—April 1 | 39 48′ | 89 23′ | 0 | 816 |
| Half-way . . . . . . . | April 1 | 39 45 | 89 18 | 0 | 816 |
| Camp CLXXV . . . . | 1—2 | 39 43 | 89 12 | 0 | 816 |
| Abdal . . . . . . . . | 2—6 | 39 31 | 8 9 | + 1 | 817 |

**Table 6.**

**Tarim river (eastern branch) from Tokus-tarim to Kepek-uj.**

| Name of station. | Month and day 1900 | Lat N. | Long E from Greenwich | Altitude above sea-level in meters |
|---|---|---|---|---|
| Tokus-tarim . . . . . . . . . . . . . . . | April 16 | 39° 43′ | 88° 35′ | 822 |
| Camp XXIX . . . . . . . . . . . . . | 16—17 | 39 44 | 88 31 | 822 |
| The great lake . . . . . . . . . . . | 17 | 39 44 | 88 30 | 822 |
| Jäken-öj . . . . . . . . . . . . . . . | 17—18 | 39 47 | 88 27 | 822 |
| Karaunalik-köl . . . . . . . . . . . . | 20 | 39 46 | 88 26 | 822 |
| Camp XXXII, Lajlik-darja . . . . . . . . . | 20—21 | 39 52 | 88 27 | 823 |
| Camp XXXIII, Sadak-köl . . . . . . . . . | 21—22 | 39 58 | 88 29 | 824 |
| Merdek-köl . . . . . . . . . . . . . | 23 | 40 3 | 88 29 | 824 |
| Kum-tscheke . . . . . . . . . . . . . | 22—23,<br>23—24 | 40 4 | 88 26 | 826 |
| Kok-ala . . . . . . . . . . . . . . . | 24 | 40 8 | 88 27 | 826 |
| Islamni-uji Ilek . . . . . . . . . . . . | 24 | 40 8 | 88 27 | 827 |
| Camp XXXV . . . . . . . . . . . . . . | 24—25 | 40 8 | 88 27 | 827 |
| Tosgak-tschantschdi . . . . . . . . . . . | 25 | 40 10 | 88 24 | 827 |
| Camp XXXVI, at the Tosgak-tschantschdi lake | 25—26 | 40 12 | 88 26 | 827 |
| Camp XXXVII . . . . . . . . . . . . | 26—27 | 40 15 | 88 25 | 828 |
| Camp XXXVIII, Schejtler . . . . . . . . . | 27—29 | 40 18 | 88 15 | 829 |
| The hamlet Tschivilik . . . . . . . . . . | 29 | 40 22 | 88 16 | 829 |
| Camp XXXIX, Kadike . . . . . . . . . . | 29<br>May 1 | 40 26 | 88 17 | 829 |
| Origin of Jätim-tarim . . . . . . . . . . | 1 | 40 25 | 88 9 | 830 |
| Kuntschekisch . . . . . . . . . . . . . | 1 | 40 25 | 88 9 | 830 |
| Camp XL, Kuntschekisch-sekötma . . . . . | 1—2 | 40 26 | 88 5 | 830 |
| Camp XLI, Modschu-kotan . . . . . . . . | 2—3 | 40 32 | 87 58 | 830 |
| Camp XLII . . . . . . . . . . . . . . | 3—4 | 40 40 | 87 42 | 837 |
| Camp XLIII, Tikenlik . . . . . . . . . . | 4—6 | 40 41 | 87 39 | 840 |
| Kuntschekisch above Kalmak-ottogo . . . . | 5 | 40 40 | 87 35 | 840 |
| Bobo-okura-kadaghan . . . . . . . . . . | 6 | 40 38 | 87 32 | 844 |
| Kepek-uj . . . . . . . . . . . . . . . | — | 40 37 | 87 29 | 852 |

# POPULATION OF EAST TURKESTAN

# CHAPTER XLIII.

## POPULATION OF EAST TURKESTAN.

East Turkestan having been conquered and subjugated by the Chinese, the vital statistics of the region are of course even more uncertain than they are in China itself. Inquiries amongst the native authorities — beks, *min-baschis*, *jus-baschis* and *on-baschis* — or amongst the *mirabs*, or "irrigation commissioners" as to the population of the different quarters of a town, of villages, or of districts only result in vague estimates, in most cases too high. As an instance, I may mention that, when in 1896 I endeavoured to ascertain the population of the oasis of Chotan, by questioning the beks, the total I received amounted to 524,000 (!), of whom 80,000 were reputed to live in the town of Chotan itself. How exaggerated this figure is need not be pointed out. Pjevtsoff gives for the same oasis a total of 160,000, and for the town of Chotan or Iltschi only 5,000 and for Jangi-schahr, or the Chinese quarter of the same town, 500 — estimates which appear to me to be pretty near the mark. Whether the beks exaggerate the numbers of those subject to them because of genuine inability to make calculations of the nature required, or whether they do it merely from the desire to impress the stranger with their authority and power, it is difficult to decide. On the other hand their obligations to the Chinese governors, or *ambans*, with regard to the collection and payment of the taxes should make them accurately acquainted with the numbers of the inhabitants in the districts and villages that are administered by them. The obtaining of accurate statistical information is however rendered difficult by the system of bribery which is universally prevalent throughout the country.

If now, in spite of the imperfection and unreliability of the material, I nevertheless venture to attempt an estimate of the population of East Turkestan, I wish it to be distinctly understood, that the attempt makes no pretentions to be anything more than approximate, and consequently must be accepted with a certain amount of caution. In each individual case I will state the grounds upon which I base my estimate and the provisional methods I have employed to obtain the different results. On the other hand I have not considered it necessary in this connection to bring together, and compare and critically examine, the various statements which European travellers who have visited East Turkestan have recorded as to the population of this or the other town. I content myself with merely mentioning at the end of this chapter a few of them *en passant*, such as Kuropatkin, Pjevtsoff, and Grenard, whom I regard as being the most reliable. Most other travellers quote more or less at random any figures that happen to be given them in the towns they visit: consequently there is no need to cite them. For some of the larger towns I have retained the figures which were communicated to me verbally by Consul-general Petrovskij, who in virtue of his official position as the agent of the Russian government in that country, and owing to his many years of residence in it, is in a better position than anybody else to have formed a definite and trustworthy opinion in these matters. Taking the whole of East Turkestan together Petrovskij estimated its total population at 2,000,000, which agrees excellently well with the result at which I arrived by estimating on independent lines. By East Turkestan I mean only the lowlands, and consequently I exclude those parts of the basin which are situated amongst the mountains. Kara-schahr and its district are not therefore counted in this enumeration, and the country of Lop is taken to be the extreme boundary in the east.

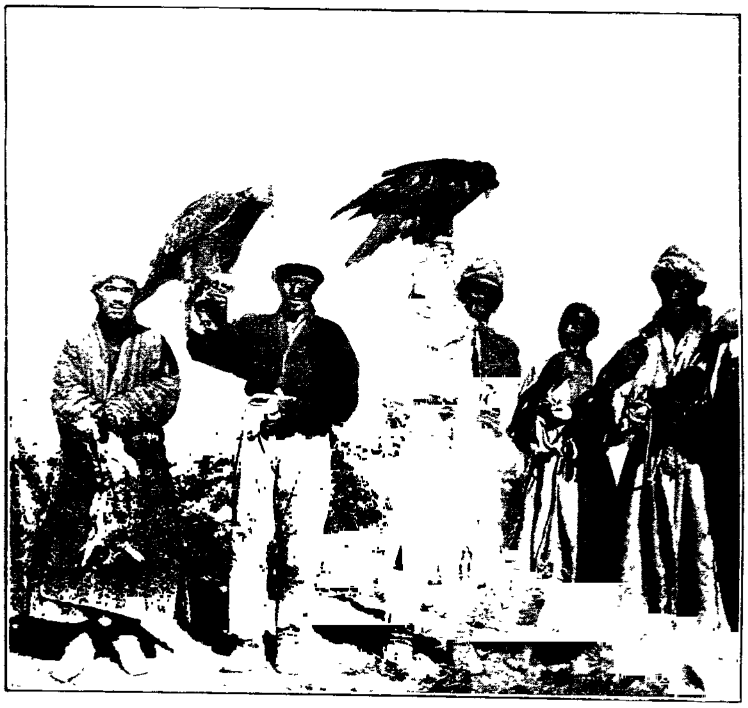


Fig. 262. MEN (TSCHIMEN).

Of the inhabitants of East Turkestan by far the greater part, or about 75 per cent., live in the villages, the remainder living partly in the towns and partly scattered as shepherds through the forests that accompany the rivers. Let us consider first the rural or village population. In the first place it is difficult to attach any clear and precise meaning to the term villages, for the so-called villages vary far more in respect of size than do the few towns which the country boasts of. While, for instance, Jarkent is twenty-five times bigger than Maral-baschi, Kan-arik is fully 120 times bigger than Jas-julghun. Add to this the difficulty of determining where to draw the line between the village and the country. For instance Maral-baschi is regarded as a town, although it is a good deal less than the village of Kan-arik: but then this last is, properly speaking, a complex of more or less scattered villages with several bazaars. Again, the name Jupogha is generally understood to indicate simply a single village, although in reality it embraces quite a large number of other villages scattered about the vicinity. And even more difficult is it to discriminate between the several villages when we reach the environs of the large towns. For example, there are some hundred villages between Jarkent and Karghalik, and I have myself enumerated more than three hundred villages belonging to the oasis of Chotan. It is obvious that all such hurried enumerations can never be complete, for even though one gathers information from different persons belonging to different parts of the oasis, it is highly improbable that each will know the names of all its villages. Indeed we may be quite certain, that there are hundreds of East Turkestan villages which are as yet absolutely unknown even by name. My 1895—96 journey alone enabled me to record some 500 the very names of which had hitherto never been noted down. Yet for statistical purposes the mere knowledge of names will help us but little. A village like Abdal (now Jurt-tschapghan) is far better known than, say, Merket, and yet the former numbers its inhabitants by tens only, whereas the latter runs up to 4,000 souls. Before Pjevtsoff's journey nobody had heard of Merket, and I was the first European to visit the village in 1895. Previous to my journey Kan-arik was unknown, although it is far larger than such old well-known towns as Maral-baschi, Utsch-turfan, and Korla. The town of Tschertschen has been known ever since Marco Polo's journey, over 600 years ago, and several of the towns of East Turkestan are named in the old Chinese chronicles.

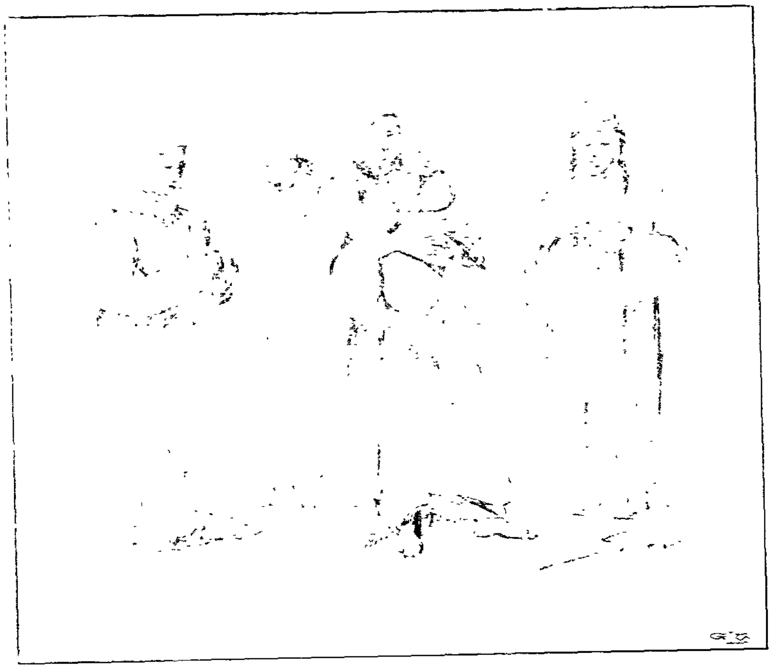


Fig. 263. WOMEN (ABDAL).

Yet nothing was known of the existence of the important village of Jupogha previous to 1895, for the simple reason that, like Kan-arik and Merket, and a host of other places, it lies off the main high-road.

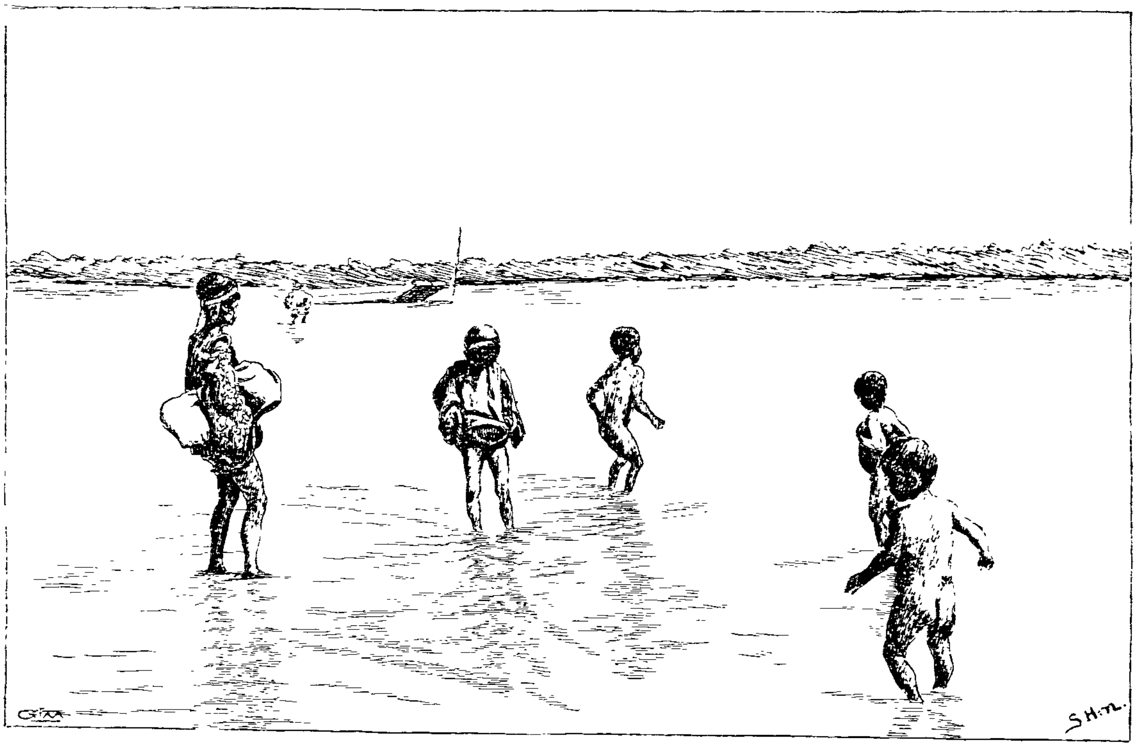


Fig. 264. CHILDREN (LAJLIK).

In the course of my travels through that country, I have habitually noted down the names of all the villages, not only along the routes by which I have actually travelled, but also along the cross-roads and side-roads leading from them. In this way I have been able to pick up a very great number of names; and yet, I am quite aware, a great number has escaped my observation, for the simple reason that they were not known to my informants themselves. In comparison with the routes I have travelled over, those I have had no opportunity to travel over are more unfortunate in the matter of geographical names, and consequently present a barer appearance on my general map of East Turkestan. This does not however by any means prove that there really is a smaller number of villages dotted along them. All the same I think it probable, that the only one of the great caravan-routes which I have not traversed, namely the road trom Maral-baschi *viâ* Ak-su, Baj, and Kutschar to Korla, really does not possess a great abundance of inhabited places; at all events long stretches of the road lead through uninhabitable tracts of desert.

What I desire to say is that at the present moment it is quite impossible to state precisely, how many villages there are in East Turkestan. During the journeys I carried out in 1894-96 I took note of 985 villages, and this covers the principal highways and the most densely peopled districts. Hence I may safely say, that this number contains all the more important places, and that the places which are not embraced in these 985 are for census purposes of minor significance. Add to these, 140 other villages which I noted during my 1899—1900 journeys, mostly from districts which I did not touch in the course of my former journey. Of this last total forty places are situated in the Lop country, and as I shall make a separate calculation for that part of the region, I may in the meantime disregard these forty. Let me say then, that we have 1,000 villages from the former journey and 100 from the latter; this gives us some 1,100 in all. The difficulty that remains is to ascertain how many are left out of account. By way of a preliminary estimate I should set down the number in this category along the Maral-baschi-Korla road at 100, and for the rest of East Turkestan at 200, so that we thus have a grand total of 1,400 villages, a figure which there is every reason to believe is not too high an estimate.

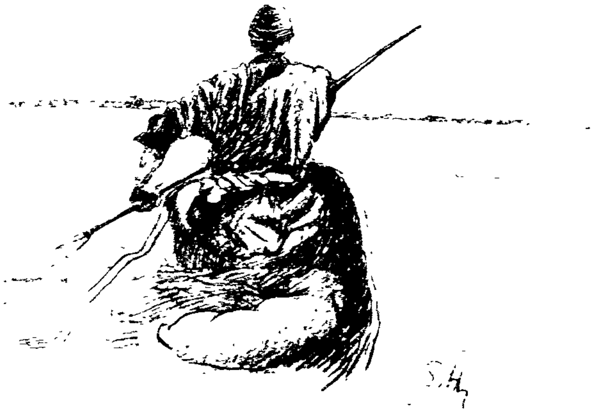


Fig. 265 A LOPMAN IN A CANOE.

But difficult though it is to determine the number of the villages, it is even more difficult to arrive at even an approximate idea of the number of the inhabitants. When you ask a bek as to the number of people in the village over which he exercises authority, he will tell you, not how many individuals there are, but how many households the village possesses, and the word he will employ, *ujlik*, meaning »steading«, »family«, »household», is rather elastic. By ujlik the Turks mean in general the number of persons who eat out of one and the same cooking-pot at meal-times, that is to say, the man and his wife, the children and servants, and very often also the sons' wives and the grandchildren. Thus an *ujlik* may embrace fifty persons, though it is seldom that it does so; but on the other hand there are ujlik which consist of only two

Fig. 266. SATMAS IN KUM-TSCHEKE.

individuals, and even sometimes of a single man or woman. Statistics as such possess no value for the native authorities: all they want to know is the number of taxable inhabitants. And in the matter of irrigation too it is more important to know the number of farms that require water than the number of the individual inhabitants.

The list which follows below contains the names of various villages picked out at random from amongst those at which I was told the number of ujlik. Upon this basis I have calculated the number of the inhabitants by taking an average of 4 persons for each ujlik:

| | | | |
|---|---|---|---|
| Kan-arik | 6000 | Simlik | 400 |
| Fajs-abad | 3200 | Oj-toghrak | 280 |
| Kara-kum | 3000 | Schinalgha | 200 |
| Mudschi | 2000 | Ala-ajghir | 120 |
| Posgham | 1600 | Ajsa-tscheke | 50 |
| Kalta-natschuk | 1000 | Jas-julghun | 50 |
| Katschung | 800 | Tschigelik-uj | 50 |
| Psän | 600 | Kadike | 40 |
| Sanguja | 600 | Islam-abad | 30 |

Fig. 267. THE HOUSE OF THE BEK IN OLD TIKENLIK.

I have divided these inhabited places into three classes, (1) large villages with 1000 to 6000 inhabitants; (2) medium-sized villages, with 200 to 1000 inhabitants; (3) small villages each with less than 200 inhabitants. In this way I obtain an average of 1112 inhabitants in each village, or 1,556,800 inhabitants for the whole of the 1400 villages of East Turkestan. But if we start from the assumption, that the large villages are relatively few, and the small villages more numerous, so that, for instance, one large village is equivalent to two moderate-sized villages or to four small ones, in such wise that the entire country should possess 200 large, 400 medium-sized, and 800 small villages, with an average of 2700, 480, and 57 inhabitants for each class of village, then the total village population would amount to 777,000. Here there is ample room for guesswork: for instance, if we suppose that the average number of persons to an ujlik is 8 instead of 4, then the total, on the basis of calculation last adopted, is 1,554,000. It would however be wiser to assign a mean of 250 households to each of the 1400 villages, giving 4 individuals to each household or family, so that the total works out at 1,400,000; which may be rounded off at 1 1/2 millions after we have allowed for the numerous unnamed farms that occur singly between the separate villages, especially in the relatively more densely populated districts, and more particularly if we count amongst the villages such large places as Kara-kasch, Jurun-kasch, Baj, Tscharklik, Avat, etc.

Jarkent, with the villages in its environs, is estimated to have a population of 200,000; the half of this I would assign to the city itself and the villages immediately adjacent to it.

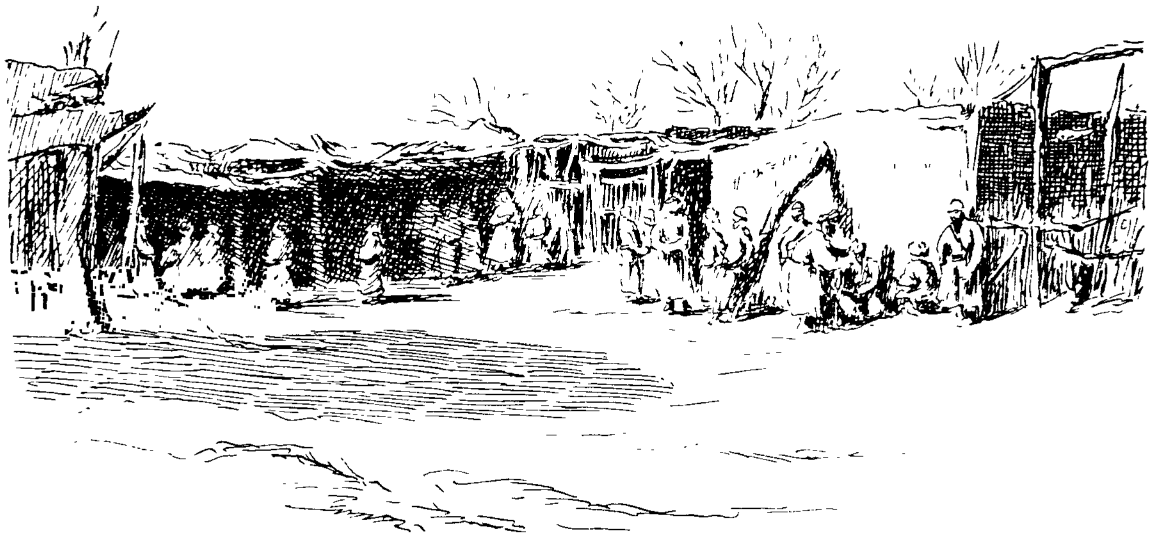


Fig. 268. ENTRANCE TO THE BAZAAR OF TAVEK-KEL.

The annexed list gives the approximate populations of the towns:

| | | | |
|---|---|---|---|
| Jarkent | 100.000 | Jangi-hissar | 4000 |
| Kaschgar | 33.000 | Maral-baschi | 4000 |
| Ak-su | 15.000 | Korla | 3000 |
| Kerija | 12.000 | Nija | 2000 |
| Karghalik | 8000 | Tschertschen | 2000 |
| Chotan* | 5000 | Utsch-turfan | 2000 |
| Kutschar | 4000 | Ghuma | 1400 |
| Tschira | 4000 | Schah-jar | 1200 |

As this table shows, several of the large villages named above have a stronger claim to be included in the class of »towns« than Ghuma and Schah-jar; but in my classification I have followed the accepted usage, which does not accord the title of »town« to Kan-arik or Fajs-abad, or even to Merket, though it does possess 4000 inhabitants, while it does allow it to Schah-jar, notwithstanding this place numbers only 1200 inhabitants. According to the above list there are sixteen places in East Turkestan which are counted as towns, although the two terms which were current before Jakub Bek's time, namely Alti-schahr, or the Six Towns, and Jäti-schahr, or the Seven Towns, are still in general use. By the »seven towns« were no doubt originally meant Kaschgar, Ak-su, Korla, Jarkent, Karghalik, Chotan, and Kerija. The total population of the sixteen towns enumerated above amounts to 200,000 persons. Consequently the settled population who carry on agriculture and depend directly upon irrigation for their sustenance amounts in all to 1,700,000. This figure is probably not too high. For example, the district of Tasghun is reported to be pretty densely populated, and the country between Maral-baschi and Matan, which is practically unknown, is estimated to possess 2400 families, or at least 10,000 souls, who depend upon the irrigation canals from the Jarkent-darja and the Kaschgar-darja.

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* In my calculation I have embraced Kara-kasch and Jurun-kasch amongst the villages.

In addition, the country possesses also a considerable number of shepherds, whom I have not counted along with the village population; indeed it is difficult to arrive at any sort of a rule for estimating the numbers of these people even approximately. While travelling along the Kerija-darja, between Kotschkor-aghil and Koschlasch, I myself estimated the shepherds there at about 150. Beside the Nija-darja their number is certainly much greater because of the lively pilgrim traffic to the shrine of Imam Dschafer Sadik. The shepherds are relatively few alongside the Tschertschen-darja; but on the other hand they are numerous in the forests of the Chotan-darja above Buksem. Beyond all comparison the greatest number of shepherds live however beside the lower Jarkent-darja and the Tarim. The observations that I myself made in the course of my drift down that river are of little use for our present purpose. It is true that on 65 different occasions we saw either shepherds with their flocks or one or more shepherd huts; but in every case it was purely by chance: we could of course only see objects that were visible from the river, so that huts which stood behind the clumps of forest or behind the thickets entirely escaped our observation. But whenever we did come into direct contact with these people, I always noted down their numbers, and found that there were on an average 8 families in each settlement. Let us suppose that there are 300 of these settlements along the river; we then get 2400 families, or about 10,000 persons. This calculation takes into account however only the narrow strip of land that runs immediately alongside the river; while as a matter of fact the entire breadth of the belt of vegetation on both sides of the stream is given up to the sheep industry, the water for these animals being drawn from dissevered or abandoned parts of the river, from boldschemals, lakes, or from wells dug in what are otherwise dry river-beds. This belt of vegetation is especially broad in the region below Schah-jar, where the industry is in such a flourishing condition; for there the Mus-art-Intschkä-darja contributes so largely to the distribution of the water. The entire strip of country which is thus occupied by shepherds may be set down as being five times broader than the narrow strip immediately beside the river of which I first spoke. Hence we may estimate the number of shepherds living alongside the lower Jarkent-darja and the Tarim at about 50 000 individuals. Nor would it be an exaggeration to set down the shepherd population of the entire country at 100,000 souls, reckoning not only those who dwell beside the rivers, but also those who use the pasture-grounds of the oases.

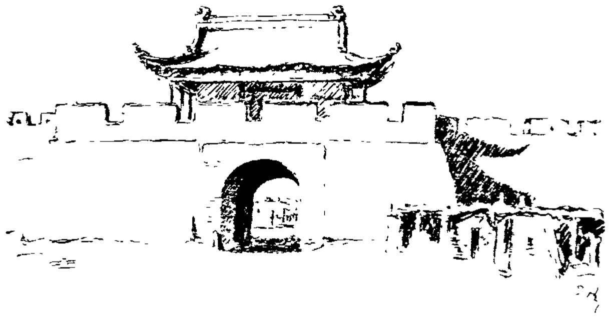

Fig. 269. GATE OF KARA-SCHAHR.

Pl. 62.

Ljustr A B Lagrelius & Westphal

VIEW FROM ROOF OF OUR SERAJ AT TSCHARKLIK.

Fig. 270. A VIEW FROM TSCHARKLIK.

There exists however a great difference between the objects for which the sheep are bred and reared in these two parts of the country. The flocks that are grazed in the vicinity of the villages are for the most part intended for killing, whereas those that feed beside the rivers are principally kept for the sake of their wool. This is especially the case in the district below Schah-jar and in the forests of the Chotan-darja. The inhabitants of East Turkestan live for the most part upon the products of agriculture, especially rice and wheat, vegetables and fruit, with mutton. This last in fact forms an essential item in their ordinary bill of fare. I have no grounds upon which to estimate what the consumption is; but if the population amounts in round numbers to two millions, then the sheep will probably be ten times as many, and this estimate is certainly not excessive when we take into account the sheep which are kept for the sake of their wool. One shepherd family is able to look after some 800 sheep, and if we suppose, as I have already done, that the family averages 4 individuals, then each member of the family, be it only a little boy or a girl, has about 200 sheep to look after. This computation again, though it is equally as arbitrary as the others I have made, works out at a total of 100,000 shepherds for the whole of East Turkestan.

I have already stated that in the calculations which I have given above, I have deliberately left out the country of Lop. By this I mean all those parts of East Turkestan which the natives call Lop and the inhabitants of which designate themselves Lopliks, *i. e.* the belt of vegetation beside the lowermost Tarim from Al-katik-uj down to the villages of Kara-koschun. Notwithstanding the plentiful and tolerably uniform distribution of the water, and the by no means unfavourable soil, the population of this part of East Turkestan is exceptionally sparse. From what I have already said in vol. I it will be pretty evident, that both agriculture and sheep-breeding are carried on to but a slight extent, and that hunting and fishing may be regarded as the principal means of subsistence that the population possess. Fishing however increases in importance as one advances down the river, and the Lopliks of the south live to a greater extent upon fish than do those of the north. The small degree to which agriculture is carried on in the Tarim delta must be ascribed in an essential degree to the peculiar hydrographical relations. In those places where the Tarim and its ramifying arms have been for a long time constant to their respective beds, these are generally so deeply cut, and the country adjacent is usually so flat, that irrigation is impossible. It is of course an essential condition for the employment of an irrigation canal that there should be some sort of a fall or slope in the surface at not too great a distance, as also that the river from which it is led off should not lie so deep that the labour of cutting the canal is an enterprise of very great magnitude.

The native beks told me, that the number of ujlik in the country of Lop amounts altogether to 535, or 9025 inhabitants, an estimation which gives not less than 17 persons to each ujlik. This total is, it is true, amazingly little, but after travelling, as I have done, across the country in various directions, it strikes me as being not improbable. Dural, the chief town in the country of Lop, is considered to possess only 150 inhabitants. Tscharklik however is gaining in importance, as the fisher population of the lower Tarim and the Kara-koschun are settling there in increasing numbers in order to devote themselves to agriculture.

The grand total of these calculations, all entirely provisional, is therefore as follows:

| | | |
|---|---|---|
| Villages . . . . . . . . . . . | 1,500,000 | inhabitants |
| Towns . . . . . . . . . . . | 200,000 | |
| Shepherds . . . . . . . . . | 100,000 | |
| Lopliks . . . . . . . . . . . | 10,000 | |
| Total | 1,810,000 | inhabitants |

But this does not quite exhaust the population of East Turkestan; for there are *kara-keschs*, *araba-keschs*, *karavantschis*, beggars, and dervishes — in a word people who spend the whole of their lives on the roads, birds of passage who have no fixed dwelling anywhere. Besides all these there are the Chinese, who may be divided into three chief categories — officials, soldiers, and traders. And then there are merchants from the neighbouring parts of Asia, especially Andischanliks (from West Turkestan), Afghans, Hindus, etc., although each of these classes is relatively few in numbers. In default of any more reliable basis of calculation, I venture to estimate the entire population of East Turkestan, in round numbers, at 1,800,000 to 2,000,000.

If we put on one side the actual Desert of Lop, the region over which these people are distributed contains an area of 450,000 sq. km., or an area almost exactly equal to that of the kingdom of Sweden. Sweden however possesses two and a half times as many inhabitants, or 5 millions in all. The density of the population in East Turkestan thus does not exceed 4 inhabitants to the sq. km. (10.4 to the sq. mile), so that taken as a whole the country is exceptionally sparsely inhabited. It is even more sparsely inhabited than Norway, which with about the same population possesses 6 inhabitants to the sq. km. (15.5 to the sq. mile). In Norway however only 0.7 per cent. of the total is cultivable; yet in East Turkestan the corresponding percentage is even less. The deserts in the latter country play the same part that the mountains do in the former. In Norway cultivation is only possible in the lower and broader parts of the valleys; in East Turkestan it is confined to the river-courses, and especially to those parts of them which are situated immediately below the foot of the mountains and where the fall is sufficiently great to admit of the practical execution of irrigation-works. This necessarily dictates a very unequal distribution of the population in East Turkestan. If we assume for each town an average area of 4 sq. km., the cultivated parts of the country will amount to about 1500 sq. km., with 1100 to 1200 inhabitants to each sq. km. In the forest tracts beside the rivers there can hardly be more than one or two inhabitants to each sq. km., by far the larger part of the Tarim basin being entirely uninhabited. The distribution and concentration of the population through the country

Fig. 271. A VIEW FROM TSCHARKLIK.

are indicated in red on the accompanying sketch map. The oases, towns, and villages form compact masses of red dots, especially numerous between Jarkent and Karghalik, between Chotan and Kerija, and around Ak-su. Along the rivers they form a faint, narrow shading beside the water and the belts of vegetation. The population is therefore distributed at certain points and along certain lines, which run spider-like across the otherwise blank spaces of the map.

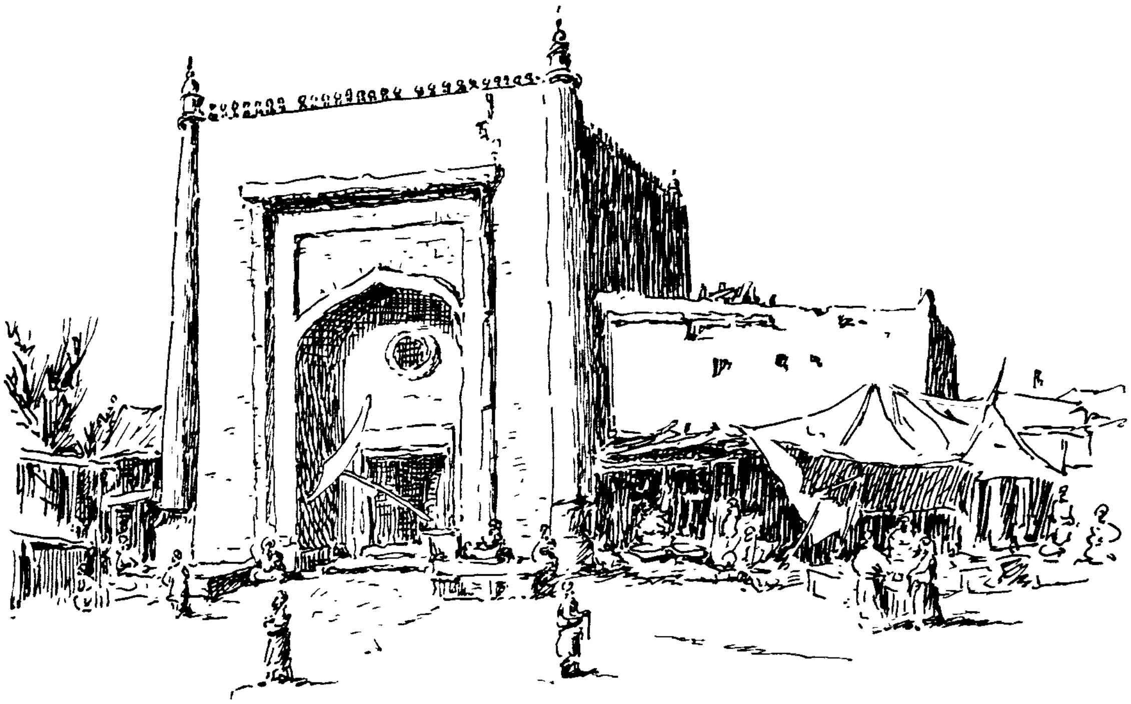

Fig. 272. MOSQUE AND MARKET PLACE IN AK-SU.

In the comparison which I have just made between the population of East Turkestan and the population of the Scandinavian peninsula, I have for the sake of simplicity proceeded upon the assumption, that the former amounts to two millions. Nevertheless I take it, that the total which I have arrived at in the table given above, namely 1,800,000, approaches nearer to the actual figure, and this conclusion is further corroborated by a consideration of the more reliable of the other estimates which have been made. Grigorieff, in his excellent history of East Turkestan, quotes from Chinese sources of various periods some estimates of population, which for the sake of curiosity I will now quote. *The History of the Older Hans* states that the population of the 31 districts of East Turkestan amounted to 39,455 families or 314,220 persons. Grigorieff asks, with justice, whether it really is possible that so extensive an area as East Turkestan could in the first century B. C. possess no more than 300,000 inhabitants, and concludes that for some of the districts the estimate is five times too small.

For the year 1812 Grigorieff quotes the following table from Chinese sources as giving the population of East Turkestan at the date mentioned.

| | | |
|---|---|---|
| Jarkent | 18,341 | families. |
| Kaschgar | 15,700 | » |
| Ak-su | 8,424 | » |
| Iltschi | 5,027 | » |
| Kara-kasch | 4 944 | » |
| Tschira | 4,288 | » |
| Jurun-kasch | 2,145 | » |
| Kerija | 992 | |
| Tak | 336 | » |
| Sajram | 1,049 | |
| Kutschar | 946 | » |
| Utsch-Turfan | 810 | |
| Bughur | 707 | |
| Kara-schahr | 670 | » |
| Baj | 593 | » |
| Schah-jar | 473 | |
| Turfan | 2,368 | » |
| | 67,813 | families. |

To this Grigorieff appends the following note, »If we assume that each 'family' is equivalent to 'household', and take it, further, that each household consists of 10 individuals, even then we do not get more than 700 000 inhabitants, which in our opinion is immensely below the reality.»*

From Forsyth's account of his mission (hence in 1873—74) I cite the following statistical statements: »Nach den obigen Angaben ergiebt sich folgende Tabelle für die Bevölkerung von Ost-Turkestan: —

| | | | | |
|---|---|---|---|---|
| Khotan | 18,500 | Häuser | 129,500 | Einwohner. |
| Jarkand | 32,000 | » | 224,000 | » |
| Jangi-hissar | 8,000 | » | 56,000 | » |
| Kaschgar | 16,000 | | 112,000 | » |
| Usch-Turfan | 2,000 | | 14,000 | » |
| Ak-su | 12,000 | » | 84,000 | |
| Kutschahr | 6,000 | » | 42,000 | » |
| Kurla | 2,000 | » | 14,000 | » |
| Kara-schahr | 8,000 | » | 56,000 | » |
| Turfan | 18,000 | » | 126,000 | » |
| Lob | 10,000 | » | 70,000 | » |
| Maral-baschi | 5,000 | | 35,000 | |
| Sirikul | 2,500 | | 17,500 | » |
| Kirgisen Steppen | 3,000 | | 21,000 | » |
| Pakhpuluk | 2,000 | | 14,000 | » |
| Total | 145,000 | Häuser | 1,015,000 | Einwohner. |

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* *Semlevjedjenije K. Rittera, Vostotschnij ili Kitajskij Turkestan*, by V. V. Grigorieff, I. 1. pp. 40 and 416.

Die obigen Zahlen sind meist die in den chinesischen Steuer-Aufnahmen enthaltenen. Der Report glaubte jedoch, dass die faktische heutige Bevölkerung der Besitzungen des Emir (Jakub Bek) weit jenen Ziffern züruckbleibe.»*

Fig. 273. TSCHIHIL-TEN, CEMETERY OF JARKENT.

Fig. 274. THE GHURISTAN OR BURIAL-PLACE OF TSCHIGELIK-UJ.

Although in this table Turfan is counted to East Turkestan and the population of the Lop-nor region is greatly exaggerated, the total is too low, because the scattered villages are virtually left out of account, and they, I am convinced, contain much the largest part of the population of East Turkestan. Wagner and Supan,** on the strength of Forsyth's estimate, put the population of the Tien-schan countries (Sin-tsiang) and Ili at the round number of 1,000,000. In the same place we find also Matussovskij's estimate of 1,500,000.

In 1876—77 General Kuropatkin travelled through the north of East Turkestan, and his account of the journey is distinguished for its accurate and reliable statements. With regard to the population, he says, »From such information as we possess, with regard to Chinese rule in Eastern Turkestan at this particular period, it is very difficult to form an exact idea as to the actual number of the population found by the Chinese in Kashgaria, or as to the amount of the taxes which were paid to them. Nevertheless, having regard to the interest raised by these questions, we will make an attempt to give, from the scattered details that have been published, figures which we will supplement by information collected on the spot — figures that will perhaps determine the amount of the population in the several circles, and the sum total of their taxes. These figures are of course only approximate, and in every case are below the real amounts. The population of Kashgaria for the period from 1760 to 1825 was: —

| | | | | | | |
|---|---|---|---|---|---|---|
| In the | Kashgar circle, | from | 100,000 | to | 150,000 | souls. |
| » » | Yarkend » | » | 200,000 | » | 400,000 | » |
| » » | Khotan » | » | 100,000 | » | 700,000 | » |
| » » | Ak-su » | » | 150,000 | » | 200,000 | » |
| » » | Koocha » | » | 25,000 | » | 50,000 | » |
| | | Total from | 575,000 | to | 1,500,000 | souls. |

Reclus takes a very comprehensive view of the extent of East Turkestan, but he reduces Kuropatkin's and Forsyth's estimates to an excessive degree when he says: »Dans les limites que lui ont reconnues des divers explorateurs anglais et

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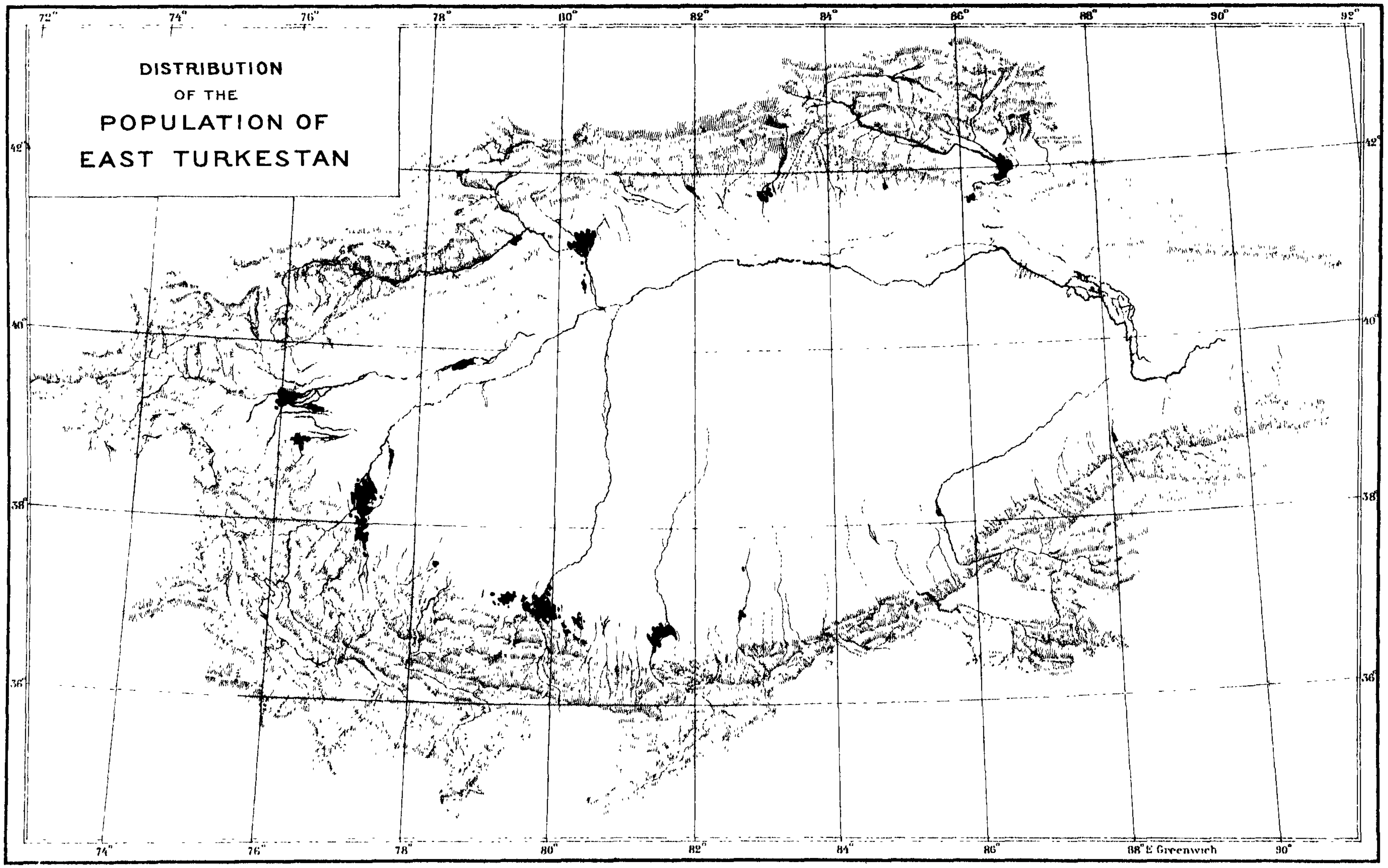
* *Petermanns Mitteilungen*, Ergänzhft No. 52: Forsyth, »Ost-Turkestan und das Pamir-Plateau», p. 76.

** *Die Bevölkerung der Erde*, VIII. p. 110.



# DISTRIBUTION
OF THE
# POPULATION OF EAST TURKESTAN

Gen. Stab. Lit. Anst. Stockh.

russes, la superficie du Turkestan Chinois est évaluée à près de 1,200,000 kilomètres carrés, espace énorme où l'on ne peut compter guère plus d'un million d'habitants, d'après Kuropatkin; Forsyth évalue l'ensemble de la population seulement à 580,000 individus. Cette région deux fois plus vaste que la France, n'aurait donc pas, dans son hémicycle de 2,500 kilomètres, plus de résidents qu'une seule des cités d'Europe de deuxième ordre, telles que Naples, Liverpool ou Glasgow. [*]

Pjevtsoff, whom I have found to be both accurate and conscientious in his statements of fact and in his estimates, says »The population of Kashgaria, who number approximately 2,000,000, are divisible into settled people, shepherds, and nomads. The settled inhabitants, about 1,800,000 in number, are divided amongst the oases in the border districts, while the nomads and shepherds, who altogether do not amount to more than 200,000, inhabit the inner slopes of the border-ranges of Kashgaria». [**]

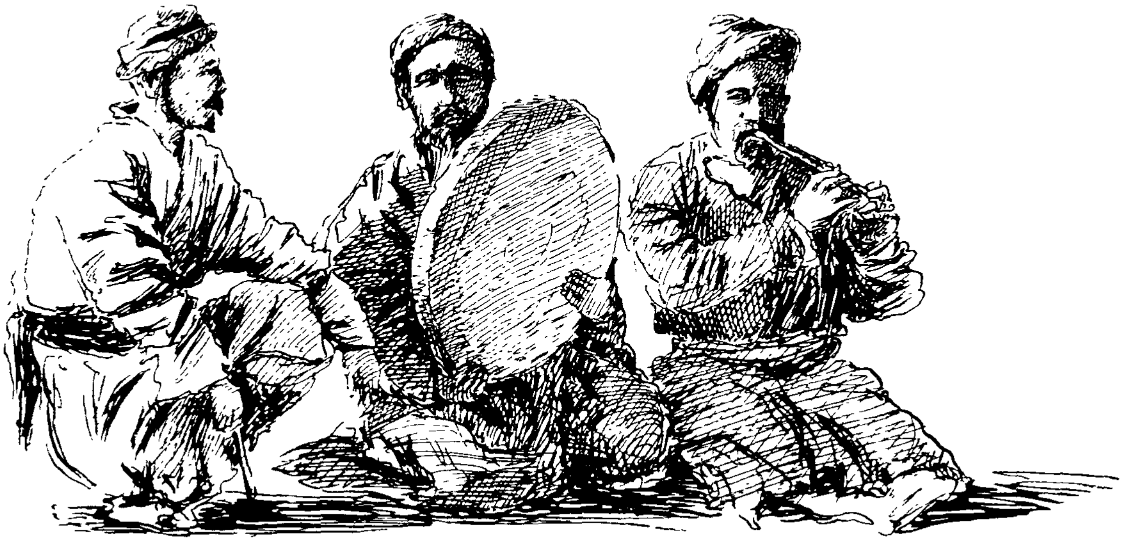


Fig. 275. TADSCHIK MUSICIANS, TAGHDUMBASCH PAMIR.

In Grenard we find the following calculation as to the total number of the population in the whole of the province of Sin-kiang: »L'ensemble de la population des quatre intendances ci-dessus dessignés[***] peut être évalué à deux millions et demi d'individus. La plus importante des quatre intendances est celle de Kachgar qui compte de 800,000 à 850,000 habitants. Le département de Yarkend, le plus peuplé de tous ceux qui relèvent de Kachgar, a 250,000 âmes, celui de Khotan en a environ 160,000, l'arrondissement de Kéria à peine 80,000, celui de Maràlbàchi 40,000.» [†]

Grenard's final result of 850,000 thus relates only to the southern half of East Turkestan or that part of the country which is subject to the *tao-t'aj* of Kaschgar.

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[*] *Nouvelle Géographie Universelle*, VII. 106.
[**] *Trudij Tibetskoj Ekspeditsij*, vol. I. p. 62.
[***] These »intendances» are Urumtschi, Ili, Ak-su, and Kaschgar.
[†] Grenard, *Mission Scientifique dans la Haute Asie*, II. p. 250.

Thus Ak-su, Utsch-turfan, Kutschar (Kara-schahr), Korla, Baj, Lop, and the whole of the course of the Tarim are not included. But, as it happens, incomparably the larger number of villages belong to Kaschgar; consequently the estimate 850,000 is too low. With regard to Chotan, Grenard arrives at precisely the same result as Pjevtsoff, and puts the number of households for the whole oasis at 30,000, or 130,000 inhabitants, while to Sava and Kara-kasch together be assigns 30,000. The small difference between Grenard and Pjevtsoff may be due to the fact that Pjevtsoff has not taken the towns into account. With regard to the density of the population Pjevtsoff calculates it as 6,370 inhabitants per geographical square mile for the oasis of Chotan, and in the oasis of Jarkent at 12,500 for each square mile. Thus the density in the latter is twice as great as in the former. According to Pjevtsoff the oasis of Jarkent possesses 150,000 inhabitants; and to these he adds 30,000 for the town of Jarkent and 15,000 for the Chinese town (Jangi-schahr).[*] For the oasis of Ak-su he estimates 140,000 inhabitants, of whom he assigns 6,000 to the town itself. In the same oasis Prschevalskij found 56,000 families, as against Kuropatkin's 30,000. I have stated above, that the Mohammedan natives of Chotan reported the population of the oasis to be 524,000. Prschevalskij obtained from the same source the total 650,000, which he justly regarded as considerably exaggerated. Other natives informed him, that an estimate of the population which was made in Jakub Bek's time put it at 237,000. With regard to this Prschevalskij says: — »This last total is no doubt nearer to the truth, though below the real figure. It seemed to me that the present population of the whole of the Khotan oasis may be estimated at about 300,000 souls.»[**]

These then are the various totals: —

| | |
|---|---|
| Kuropatkin . . . . . . . . . . . . | 1,200,000 |
| Petrovskij . . . . . . . . . . . | 2,000,000 |
| Pjevtsoff . . . . . . . . . . . . | 2,000,000 |
| Matussovskij . . . . . . . . . . | 1,500,000 |
| Forsyth . . . . . . . . . . . . | 1,000,000 |

The mean of these is 1,540,000; while the mean of the first three, which are the most trustworthy, is 1,700,000. In default of later and more thorough estimates, I will therefore content myself with observing, that the total population of East Turkestan probably does not exceed 2,000,000, and probably does exceed 1,800,000; and the latter I regard as being the safer estimate.

The primary, indeed the exclusive, object of my journey being to make geographical investigations, I had neither time nor opportunity to institute inquiries of an ethnological, ethnographical, anthropological or administrative character; and these studies I found myself able to omit with all the better conscience, seeing that we already possessed Grenard's excellent work *Le Turkestan Chinois et ses Habitants*, forming the second volume of his *Mission Scientifique dans la Haute Asie*, a work

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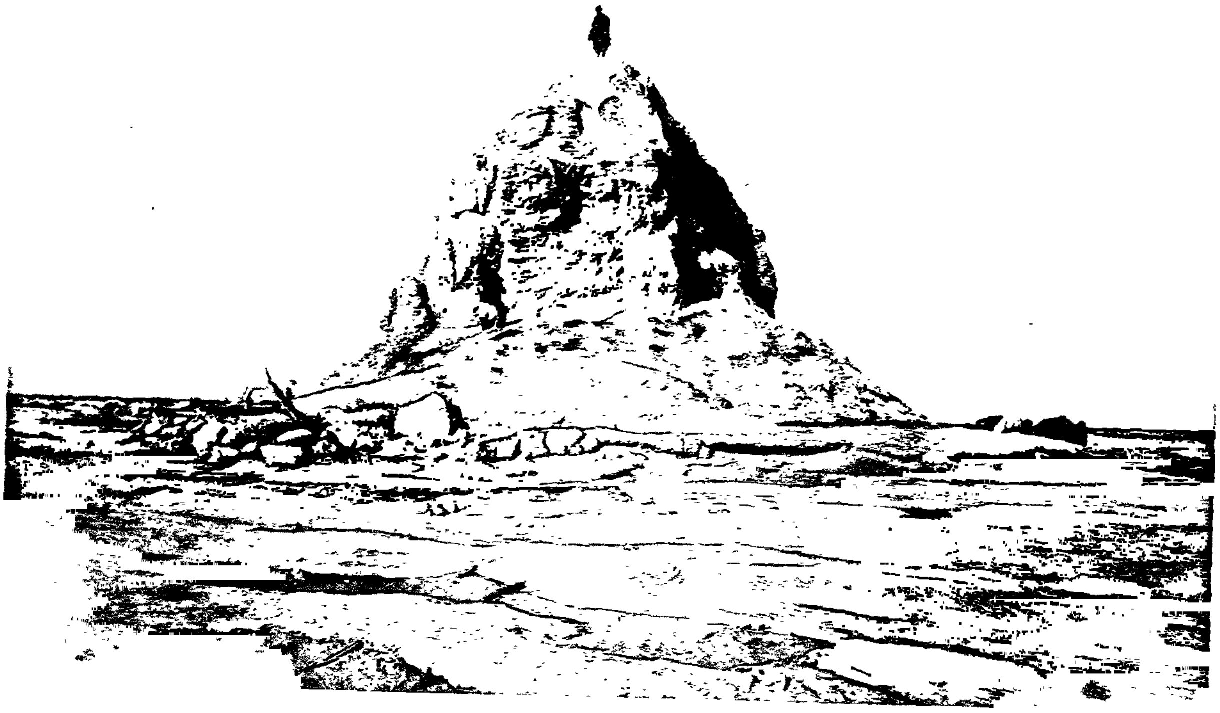
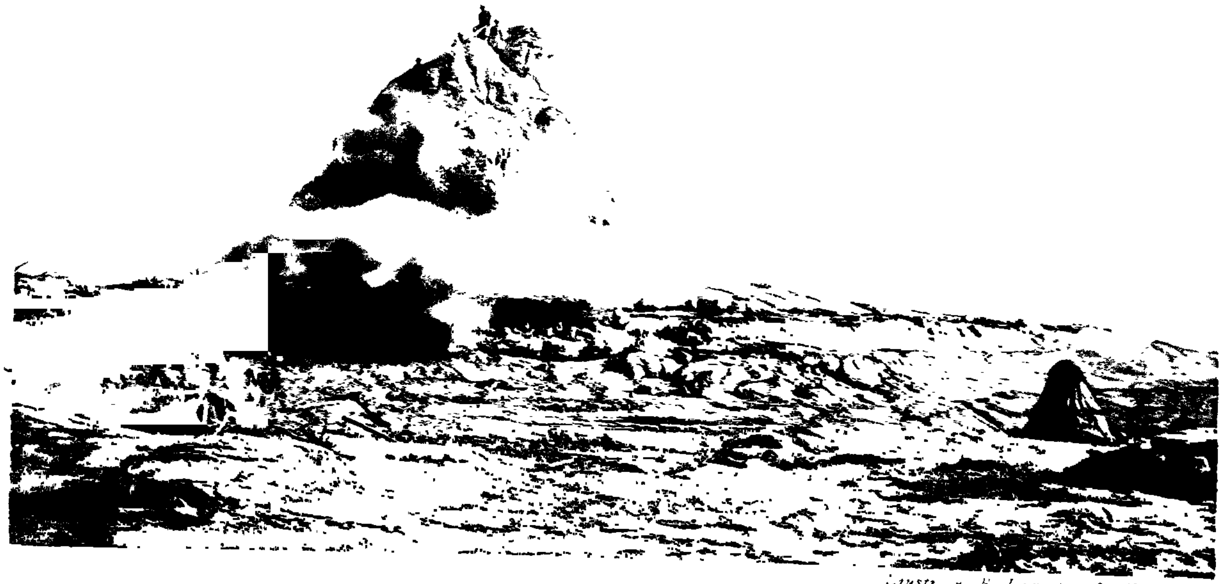
[*] *Trudij* etc., pp. 81, 82, and 114.

[**] *At Kjachtij na istoki Scholtoj Reki*, p. 455.



SOLITARY TOWER OF MARCH 3RD 1901



Ljustr. A. B. Lagrelius & Westphal

CLOUD OF DUST RAISED BY DEMOLITION OF UPPER PART OF TOWER — TOWER *A* AT LOÛ-LAN

which I can most cordially recommend to all who are interested in the people as well as in the geography of that region.

Fig. 276. THREE GIRLS.

However with the view of showing that I have not been altogether indifferent to the people, I propose at the end of the Fourth volume of this work to add a two hundred types of the inhabitants of Central Asia whom I have sketched during my various journeys.

# THE RUINS OF LÔU-LAN

# CHAPTER XLIV.

## THE RUINED HOUSES OF LÔU-LAN.

In a special section of this work Prof. A. Conrady and Mr. Himly give the results of their scientific examination of the MSS. material and other objects that I brought home with me from Lôu-lan, and discuss the historical and sociological questions that these things suggest, and upon which they throw new light. For the scientific details arising out of these questions I therefore refer the reader to the part of this work which is published by Prof. A. Conrady. In what follows I propose to describe simply the ruins at the various places where I made my »finds», and to append a few words descriptive of the region in which they occur.

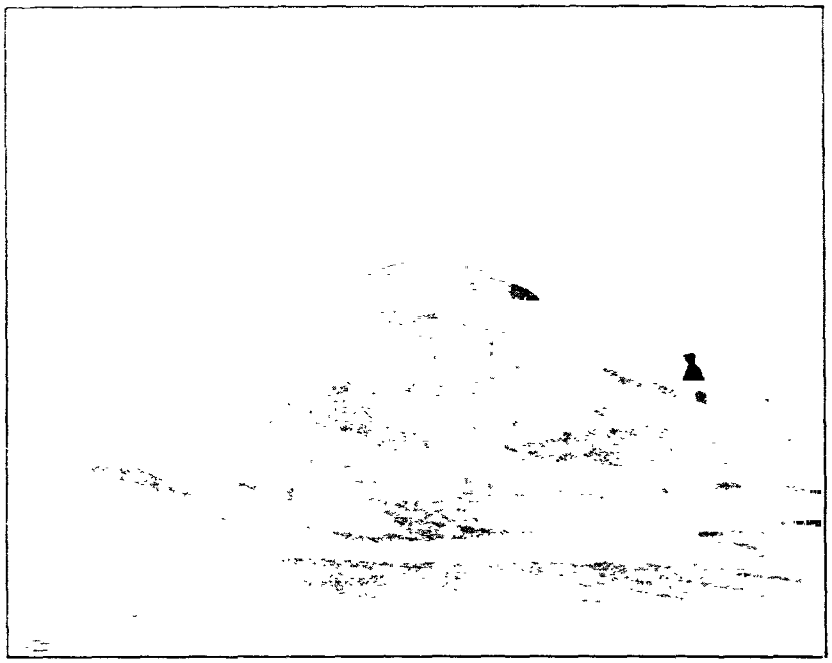


Fig. 277. RUINED TOWER FOUND ON MARCH 28.

We discovered the first traces of human habitations on the 28th March 1900, when crossing the Desert of Lop for the first time, at a distance of two days from Alt-misch-bulak. The circumstances in which we then were, as well as the advanced season of the year, rendered it impossible to make even a short stay in the desert, more especially as the supply of water which we had brought with us from the spring was barely sufficient to last us to the Kara-koschun. On the afternoon of the day named we came across numerous shards of broken earthenware vessels, one or two decimeters in diameter. Shortly afterwards we lighted upon the remains of two wooden houses, standing upon small platform-like elevations of the clay surface. Amongst these we picked up a number of wood-carvings, small sacrificial bowls or cups of clay, vast quantities of fragments of earthenware jugs and dishes, Chinese copper coins, a sort of copper pin, etc. etc. To the S. 58° E., at about an hour's distance by walking, was a cupola-crowned clay tower, much the worse for wear, and from it three other similar towers were visible to the S. 71° E., N. 59° E., and N. 88° E.

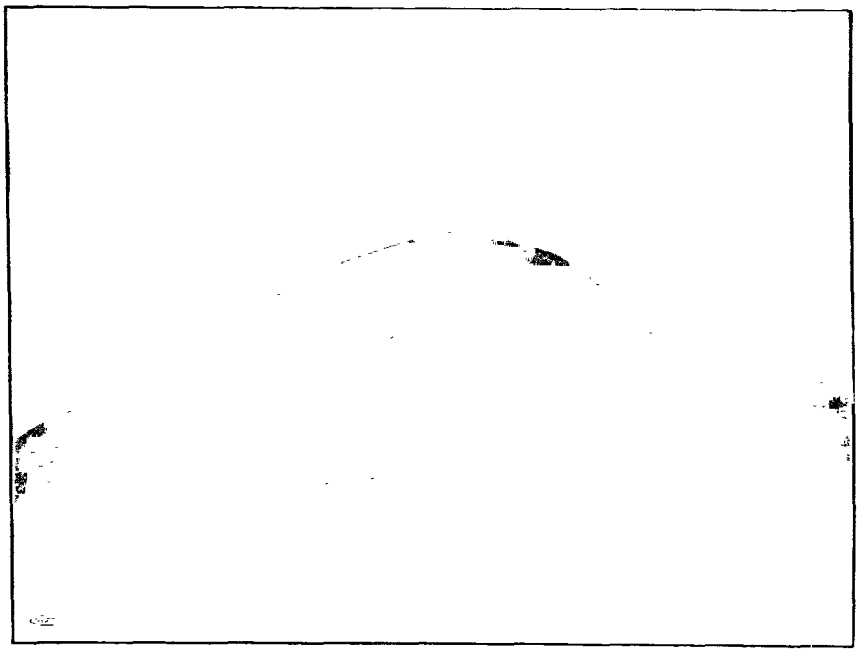


Fig. 278. ANOTHER VIEW OF THE SAME.

The more easterly house, which rested upon a platform 2½ m. high, was rectangular in shape, stretched from N. 33° E. to S. 33° W., and measured 6.60 m. in length, while the short wall was 5.60 m. Of the original structure nothing remained *in situ* except the four ground or foundation beams; all the rest had fallen, and the roof was blown over to the west side, where it formed an inextricable pile of ruins. From these it was not possible to deduce any conclusion as to the shape that the roof originally bore, that is to say whether it was flat, or pyramidal, or had the corners curved upwards like horns. Some of the posts (uprights) were turned or carved, the carvings representing human figures, or rather deities, and the motif of the lotus flower was also especially prominent. One post, which must have been one of the four corner-posts, was

5.02 m. high, so that the structure as a whole must have been an almost perfect cube. In the middle of the ground-beam on the western side there was an indentation 1.83 m. broad, where the door had been; the door, which was 2.3 m. high, had faced N. 57° W. The two side-posts for the door were pretty strong, and were fixed into the bottom beam in the manner shown in the accompanying cut (fig. 281). The two lintels consisted each of a short plank fastened to vertical side-planks, and each half-door swung upon a pivot in the ground-beam and upon another pivot in the lintel. The ground-beams were 33 cm. broad and 21 cm. high. Considering the fragmentary condition of the ruins, it was impossible to attempt a reconstruction of the house.

Fig. 279. OUR CAMP OF MARCH 28.

The other house, or perhaps rather row of houses, was of greater dimensions. It lay 20.4 m. west-north-west of the first one, and, like it, stood upon a platform 2½ m. high. The longer side of the entire complex measured 52.4 m., and was situated N. 22° E. to S. 22° W., that is almost parallel to the longer side of the first house. The windward sides of both mounds were seriously damaged by the wind: in the case of the larger house the tie-beams of the foundations were entirely exposed at their east-south-east ends and hung in the air a couple of meters above the ground. Between the two mounds there was a hollow or passage, which continued a good way farther in the direction S. 40° W., though there it was broader, and was inclosed between terrace-like jardangs. The fact of the two long walls of both houses lying parallel to the direction of the prevailing wind would seem to indicate, that the inhabitants had endeavoured to protect themselves as far as possible against it, though it would, it is true, be less felt when the country was far and wide planted with forest. Their position has however facilitated the erosive and corrasive action of the wind upon the dry clay soil, and this is the cause of the distinctly marked hollow between the two houses. It is however rather due to accident that the south-westward prolongation of the nearest gully forms an immediate continuation of the hollow; the former would no doubt have come equally into being had the houses and their mounds never existed.

A closer examination of the beams I have lately alluded to as hanging suspended in mid-air proved beyond a doubt, that they were originally laid upon per-

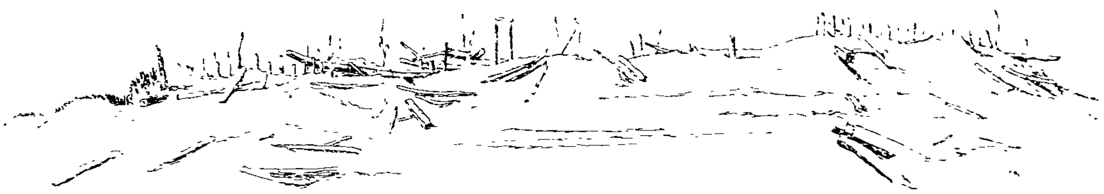


Fig. 280. VIEW OF THE BIG HOUSE.

fectly level and horizontal ground. The two mounds and the hollow between them, as also the depressions on their outer sides, all came into existence at a subsequent date. The mortice cut (see fig. 281) on the under side of the extreme end of the cross foundation-beam proves that the longer side-beam was placed under the cross-beams, which again were likewise fitted into mortices cut in the long beam. This latter now lies in a condition such as to be hardly recognisable at the eastern base of the platform, where it has fallen since the underlying ground was excavated and blown away. At the present time the ends of the cross-beams project about 3 m. beyond the platform, and the wind is still continuing its undermining work. But the timber that still remains on the top of the platform, equally whether it belonged to the foundation-beams or to portions of the walls and roof which have fallen in, affords an efficient protection to the platform, and sufficiently neutralises the effects of the wind's erosion. It is on these platforms alone, then, that the surface remains at the same level that it stood at when these houses were built. Another proof that nothing but the wind can have carved out these platforms is to be

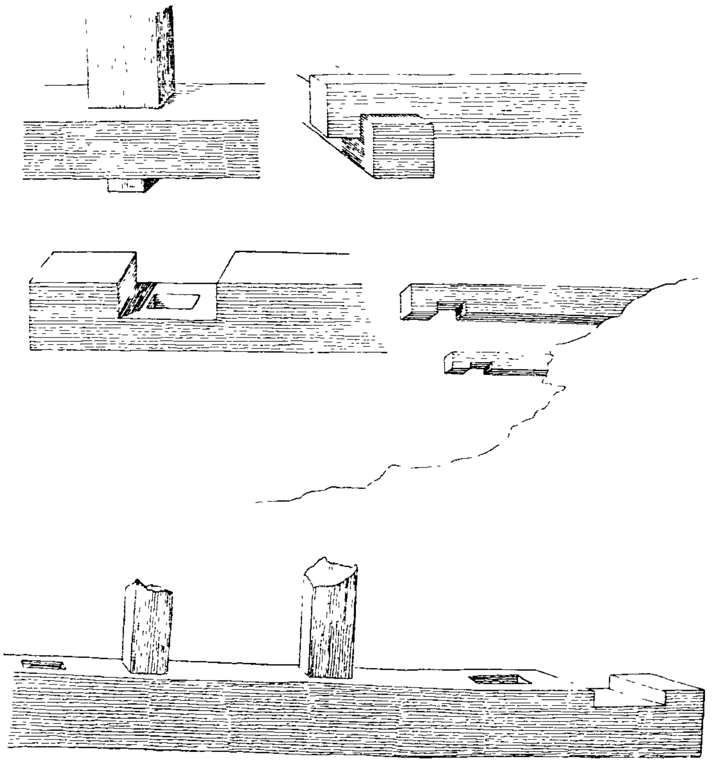
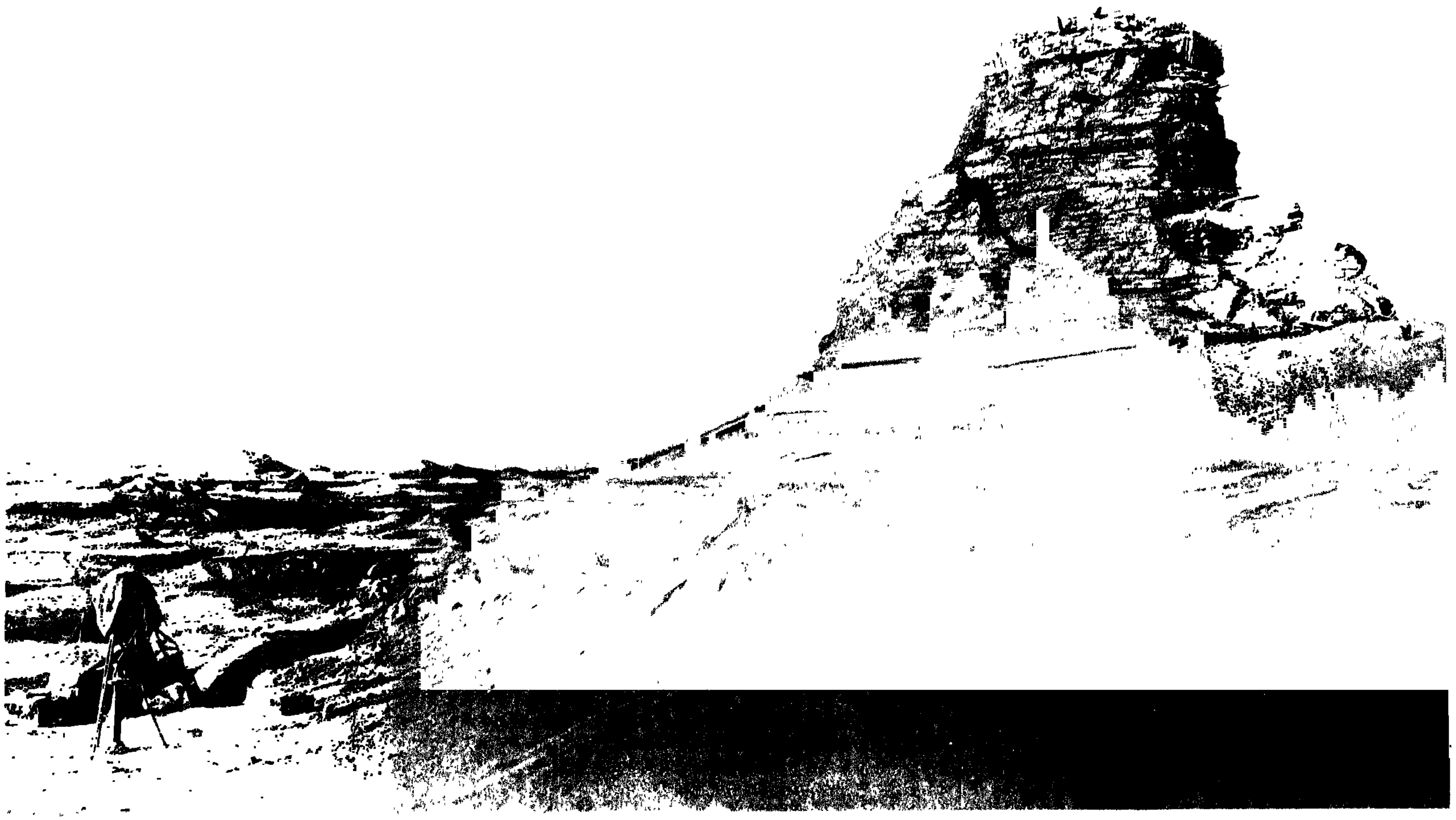


Fig. 281.

Pl. 65.



Ljustr. A. B. Lagrelius & Westphal.

TOWER AT CAMP CLIX, LOOKING NORTH-WEST.

found in the fact that, whereas those sides which are exposed to the wind are greatly undermined and almost vertical, the leeward faces are intact, and present a more gradual slope down to those parts of the surface which are not protected by either houses or vegetation.

In an earlier chapter I have enlarged upon my conviction, that it is precisely the uneven distribution of the vegetation — trees, bushes, and reeds — which originally gave rise to these jardangs and to the gullies between them. After the country dried up in consequence of the Tarim having changed its course, the places that first fell a victim to the wind's excavating power were those that were distinguished by an absence of vegetation, or where the vegetation was thin and scanty. Other places were protected by the vegetation, and consequently formed elevations, that is jardangs. I look upon the 2½ m. high platforms or pediments upon which these houses stand as an eloquent proof of the correctness of my theory. These powerful beams naturally form a much more efficient protection for them than does a solitary tree-trunk and its roots, or than a small patch of kamisch stubble. In consequence the platforms upon which the houses stand exhibit precisely the same shape as their foundations, and the position of the beams shows that nothing has been blown away from the top. In the jardangs that are held together by vegetation it is difficult, if not impossible, to determine how far and to how great a degree their upper surface has been filed down by the wind. It was for this reason that I was unable to regard the depth of the eroded gullies as a sure indication and measure of the effects of the wind-erosion. But this difficulty no longer exists in the case of the platforms we are considering; for they do show, and show unmistakably, that a layer 2½ m. deep has been planed off the circumjacent surface. Nevertheless one uncertainty still remains, namely this: we do not know at what epoch the Lop-nor shifted its position, nor how long after it did so the moisture surviving in its basin was able to nourish the vegetation sufficiently for it to offer successful resistance to the wind. But it is extremely probable that the basin of the lake dried up rapidly once the water had left it for another quarter.

I will now proceed to describe the large house-complex. At its south-south-west corner we found a quadrilateral apartment or house, measuring 15.6 m. in breadth by 15 m. in length. Its walls were formed of basket-work made of tamarisk-branches, and were pretty substantial; but they only projected one foot above the slight layer of sand which had there heaped itself up under the shelter of the mound or platform. The fragments that projected above the sand appeared to suggest, that another similar apartment had originally stood immediately S.S.W. of the first structure. There was a mat, woven of reeds, almost entirely buried under the sand; it was precisely like the mats which are in use all over East Turkestan at the present day, partly to put under the ordinary felt-carpets (*kigis*), or under Chotan carpets indoors, on terraces, or in bazaars, partly also to hang up as awnings against the sun in the narrow streets of the bazaars in towns and villages, the reed-mats being supported by long thin rods of wood. What object the mat in question served it would be difficult to say; but, judging from the materials of which the walls were constructed, I should infer that the apartment was covered with kamisch mats, and probably served as an out-house, stable, or so forth.

This apartment is separated from its nearest neighbour on the north-north-east by a gangway or passage, 6.2 m. broad, which no doubt was uncovered. This new house is 13.8 m. broad and 9 m. long, and contained three rooms, two of them quite small. From the smallest of the three, on the south-west, a door opened out into the large room; while from the other small apartment a door opened out to the north-north-east. Each of the outside walls of the largest room contained 22 upright posts, the corner-posts and a central post in each side being especially strong. In the middle of the north-north-east wall the door-frame still remains, indeed the upper lintel has not even moved. The side-posts are 2.44 m. high, and of this 1.87 m. still project above the surface of the ground, the remainder being buried. The ground was covered with drift-sand, dust, and various broken pieces of timber. Both the side-posts were fitted into mortices cut in the foundation-beam that formed the threshold.

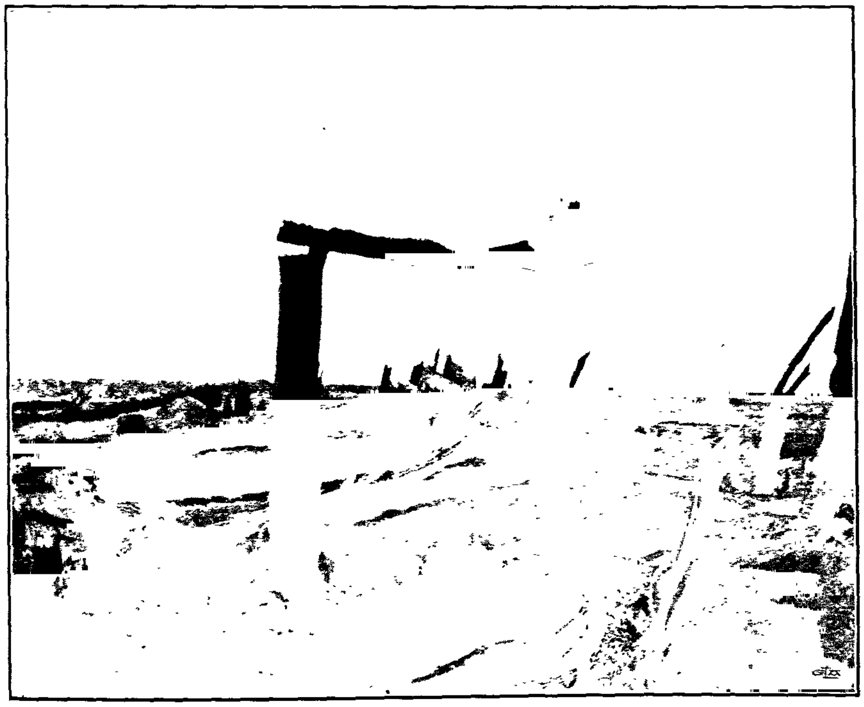


Fig. 282.

In the interior of the largest room there were four vertical posts, three of which still stand upright, though they are severely damaged by the winds and by sand-abrasion, especially on the side from which the prevailing winds blow. These four interior posts, which form a smaller square (5.1 m.) inside the larger plan of the room, were not connected by walls; their object probably was to support the roof. Whether that was flat or pyramidal I was again unable to make out. The four posts are beautifully turned, and narrowed towards the top. These timbers afford an excellent illustration of the great preservative power of the sand; for those parts of the beams and posts which were buried are still sound, and retain their hard, compact consistency, and their fresh yellowish red colour.

But those parts that were exposed to sun and wind were soft, brittle, and grey, with long cracks running down them endwise, as well as burst into little squares or twisted like corkscrews, exactly like the withered poplars in the same locality. Posts that were originally four-square have been planed round by the wind, though those parts which were buried in the sand still retain their sharp edges. Round some of the mortices, into which the tenons of other beams were fitted, we still saw the marks of the carpenter's pencil when he outlined them on the timber.

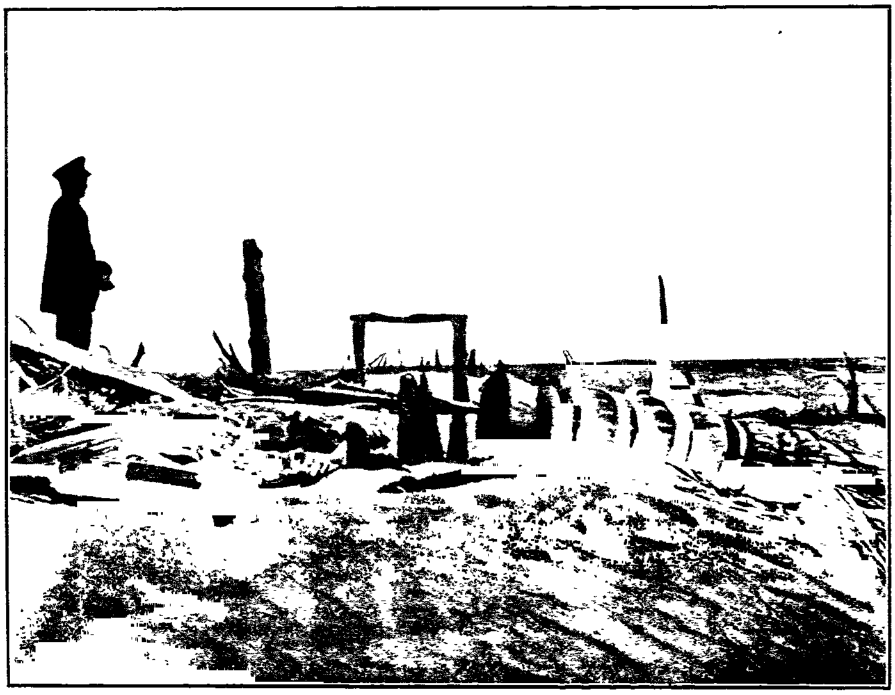


Fig. 283.

The sides of the smallest apartment measure 5.8 and 3.0 m., and those of the other small room 5.8 and 6.0 m. respectively. If, as I have assumed, the four interior columns of the largest apartment were used to support the roof, and if that was pyramidal in shape, then the two smaller apartments must have stood outside its span, and been covered independently.

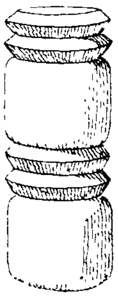


Fig. 284.

The next house or room in the complex measure 12 m. in length and 18.03 m. across the end-walls; how this was divided could not be ascertained from the foundations that survive. All that remain are five cross-beams and the two side-beams. A massive round pillar that was lying on the ground had probably supported the roof. Possibly the roof of this apartment was supported in the same manner as that of the larger room I have just described, namely by four posts set four-square, but of the four only one is left. The inside walls of this apartment consisted of bundles of kamisch set up vertically on end, and securely fastened in places to horizontal stays; the fragments of rope with which they were tied back are often in a good state of preservation.

Then comes a wing which measures 5.9 m. in length and 18.03 m. in breadth. It is divided into five rooms, the middle room being the largest, while those on each side of it are merely passage-ways each a meter wide. The walls in this structure were composed of narrow planks reared on end. Here too the roof consisted of woven kamisch mats. These remains lay on the west side of the house, having been swept off and deposited there by the last storm that they were unable to withstand; this happened without doubt at a much later period than that at which the houses were deserted by their inhabitants. These five apartments appear to have been used as sheepfolds, to judge from the layer, or rather several successive layers, of sheep-dung, a foot thick, which was in a relatively fresh condition, preserved under a thin coating of sand and dust. The smallest apartments were possibly intended for the lambs, after these were separated from the ewes. Finally, at the extreme north-east end of this long complex of buildings is a passage, measuring 3.4 m. by 18.03 m. At the apex of the gable is a massive round strong pole, indicative, apparently, of a roof sloping downwards in both directions. The pole is 3.2 m. high, while the side-posts are two-thirds of a meter lower.

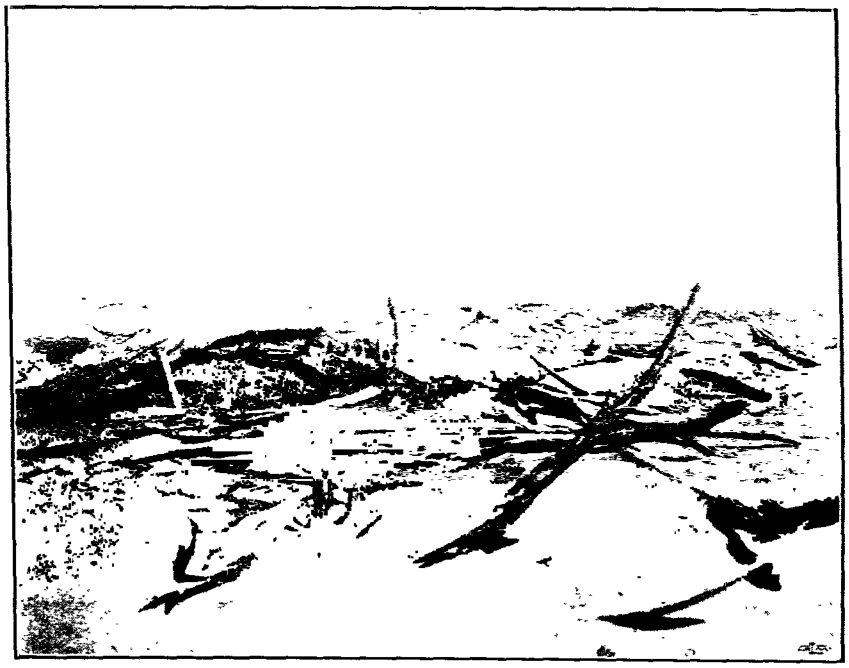


Fig. 285. VIEW OF RUINED HOUSES, MARCH 28.

A comparison of the two sets of buildings on the two separate platforms showed that the smaller single house was not only more carefully constructed, but also more tastefully decorated with wood-carvings, pierced latticed windows of different patterns, turned pillars, etc. It may have been a small temple, as the little sacrificial clay bowls would indeed seem to indicate, although they alone are not sufficient to justify such a conclusion. My first impression, after seeing these two structures only, was that what we had discovered was a former *örtäng*, and that the smaller house had

Pl. 66.

Ljustr. A. B. Lagrelius & Westphal

WHEEL OF ARBA AND VARIOUS FRAGMENTS OF CARVED WOODEN ORNAMENTS.
JARDANG RIDGES IN BACKGROUND.

been either a temple or the dwelling of an official, and the larger the caravanserai or rest-house, with stables for horses and winter sheepfolds for sheep, these animals being partly consumed by the inhabitants of the place and in part sold to travellers. In that case the house with the three rooms and four columns might very well be the dwelling-house of the caravanserai-keeper and his offices. I had no hesitation in concluding that this caravanserai or village, the last surviving remains of which we had discovered, and which was probably once surrounded by slighter and more perishable kamisch huts, was situated on the great highway that I touched in 1896 at Saj-tscheke and Jing-pen, and several other points, and which formerly ran along the southern foot of the Kuruk-tagh to Tung-chuan. The existence of a former lake is evidenced by the abundance of *Limnæa* shells and thick kamisch stubble; and on its northern shore the village stood. The lake-shore was irregular in outline, with deeply penetrating bays, projecting capes, islands, and promontories. It was equally evident, that the Kuruk-darja once entered this lake and fed it, though its mouth was a good bit to the west of the caravanserai. This last may possibly at one time have been one or two hundred meters distant from the open water; and the great number of pieces of broken pottery seem to indicate that drinking-water must always have been obtainable at the caravanserai, so that the water of the lake was no doubt fresh. The earthenware vessels, which are in many cases of considerable size, are of different shapes, as shown in the accompanying cut (fig. 286). We also discovered something that looked like the slag of glass or enamel, which would go to show that the people knew how to burn their pottery and enamel it on the spot. Both the execution and the motives of the wood-carving prove unmistakably that the people who dwelt there were not Muhamedans: the Chinese are the only people who could have produced such work.

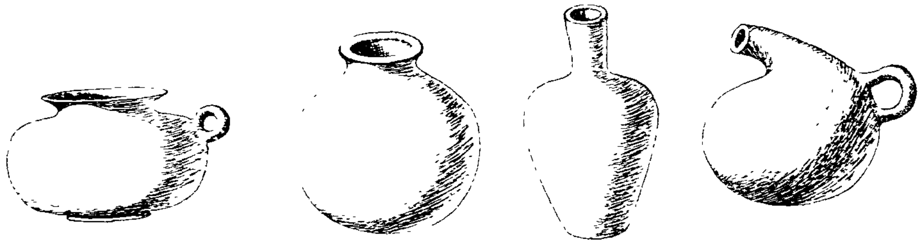


Fig. 286.

It was on 3rd March 1901 whilst travelling from Altmisch-bulak to the Kara-koschun that we discovered the first ruins in this same locality. Again it was a small complex of three houses standing side by side. The middle house was built of red burnt bricks, the bricks being rectangular in shape and the dimensions 32 × 21 × 5 cm. The foundation wall is a meter thick, and does not rise more than one, or at the most two feet above the ground; it forms a quadrilateral, 5.75 by 5.37 m. in length. S. 35° W. of this there is an oblong house of wood, the ruins of which are in great part destroyed. The long wall measures 58.6 m. and the short wall 10.3 m. The best preserved portion was at the south-west end; this measures 8.6 m. by 10.3 m., and is divided into six small apartments. The rest of the structure is very indistinct; possibly it was nothing more than a closed-in courtyard. North of these two, and barely 100 m. away, are the faint traces of a third house, which was built of wood, but had a foundation-wall of brick; from which it may also be inferred that the first house was for the greater part built of wood and rested upon a brick foundation. A well-preserved beam has the following dimensions — 7.82 m. × 0.35 m. × 0.17 m., so that this locality must once have grown magnificent toghraks, quite as finely developed as any in the primeval forests of any part of the Tarim. Here we picked up various fragments of a hard stone-like earthenware, which had been burnt black and red, a small iron ball, an object of copper shaped precisely like a rowlock, some Chinese copper coins, and a couple of small red clay cups.

An hour east of this place is a solitary tower of sun-dried brick (adobe), of which I append a photograph. It is nearly 10 m. high, and its skeleton consists of poles and faggots of kamisch; but in spite of being thus strengthened, it had fallen in at one or two places. But there was no other sign of human habitation in its neighbourhood.

The most important ruins we discovered lie rather more than an hour south-east of the tower I have just described. There I stayed from the 4th to the 10th of March (Camp No. CLIX). I propose to give now a chronological summary of the finds that we made during these days. A first preliminary examination resulted only in the garnering in of a heap of worthless rubbish. And yet it was not without its value as indicating the conditions under which these people lived. A massive and well preserved wheel of an *arba* (cart) sufficed to show that carts were formerly in use in that locality, and that there was then a driving road, although the entire country is now everywhere so furrowed by the wind that the use of even riding animals is difficult. Certain ornamental pillars were as regularly rounded as if they had been turned on a lathe. Amongst the remaining objects found were a piece of red cloth, like that which the lamas make their robes of; felt rags; a couple of bunches of brown human hair; jaw-bones and other parts of the skeletons of sheep and oxen; the droppings of both these animals, of horses, and of camels, though this last might also possibly have been left by wild camels, for it did not appear to be particularly old. The protective layer of sand and dust will explain why this manure was not pulverised to dust and blown away. Further, we also picked up a small lead vessel, with a wooden peg fixed in it — possibly a glue-pot; — portions of clay vessels, some with, others without, simple ornamentation; an ear-ring; a number of Chinese copper coins coated with verdigris.

Quite close to the high clay tower, at the foot of which we were encamped, there stands a relatively well-preserved house, with several posts still standing upright and plastered walls of interwoven tamarisk and kamisch. The interior of this house we dug out thoroughly, but without obtaining any result. One great difference between the ruins in the Desert of the Kerija-darja and these ruins of Lôu-lan is that the former are for the most part buried under sand and dust, so that nothing projects above the dunes except a post or a piece of wall here and there. Consequently there does exist some hope of finding there the objects that were left behind by the inhabitants when they abandoned their houses, and such reliefs and wall-decorations as there happen to be are, as Stein's excavations proved, very well preserved.

The ruins of Lôu-lan on the contrary are not only not sanded up and protected by dunes, but they are actually in the highest degree exposed to wind and weather, and these have moreover excavated the surface around them in such wise that each house stands on a separate platform, while to the leeward, that is to the south-west of each such platform or mound, only the very slightest amount of drift-sand has been able to settle and remain. Any objects that may have been left here must therefore lie on the surface, swimming as it were on the ground, and thus would be easily destroyed. Consequently there survive only a few objects which happen to have been especially favourably situated with regard to the wind. In excavating a house such as that which I have just referred to we were therefore digging down through the original solid ground underneath, into which no objects are able to penetrate.

Fig. 287. CLAY VESSELS WITH ORNAMENTATION.

In the ancient village where we encamped we counted nineteen distinct houses; but if we add to these the separate heaps of beams and traces of walls, the number will easily amount to thirty. Moreover there were in all probability several kamisch huts as well, so that one might justly speak of a large village or a small town. The houses which I measured are generally oriented from N. 30° W. to S. 30° E., and from this direction the deviations are but slight. When viewed altogether, they forms a zigzag line from north to south, the starting-point of the line being the tower, which appears to have been encircled at its base by some sort of structure, such as a circular platform with a balustrade, a low shed, or so forth. At any rate there were a great number of beams, posts, and planks scattered round about it.

Starting from the tower, then, we have, close to its south-east base, a confused heap of beams and posts which pretty obviously belonged to a house, though the way in which they lay afforded no clue to its ground-plan. There were no foundation-beams visible. The house would appear to have fallen to pieces all at once, in such a way that all the materials of which it was built were jumbled together in indistinguishable confusion. South-south-east of the tower is a structure of two rooms. In its case it was easy to follow the plan, for its foundation-wall was composed of bundles of kamisch arranged horizontally one upon the other, this same material being also employed in several of the other houses. Although kamisch apparently possesses little stability and durability, it must nevertheless be endowed with a respectable power of resistance, seeing that, at all events at the bottom, it has been able to maintain its position for 1600 years. In what way the walls were constructed did not appear, though probably up to the height of two or three meters they consisted of similar sheaves of kamisch, which were of course strengthened and kept in place by a skeleton lattice-work of thin vertical poles, to which the sheaves were lashed layer after layer. This I infer from the fact that also in the house marked D the walls consisted of a combination of kamisch sheaves and vertical posts, of which most of the latter still survive, while the kamisch was preserved only on the ground. In the house C the poles were probably thinner, and consequently have been destroyed. Possibly the interior walls were built of more durable materials, for example plastered basket-work, of which there were specimens remaining also in the house D.

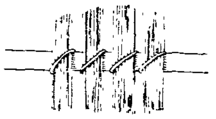


Fig. 288. SHEAVES OF KAMISCH BOUND TO A HORIZONTAL POLE.

The front of the house C stretches from N. 25° W. to S. 25° E., and is 23 m. long; all that remains of it are a couple of long beams next to the tower. In the middle of the front-side some smaller posts indicate a door or some species of simple architectural decoration. The partition-wall between the two rooms is 17.3 m. in length. One of these apartments appears to have leaned directly against the base of the tower at its south-south-east corner; the other forms a quadrilateral, and within it lay three beams in the positions shown in the accompanying plan (Pl. 67). On the slope of the platform outside, along the south-south-east wall of the structure, a certain amount of drift-sand has accumulated; this wall measures 15.8 m. in length.

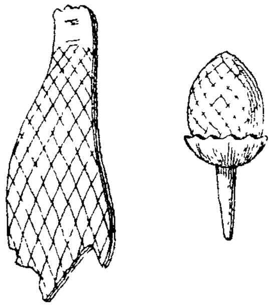
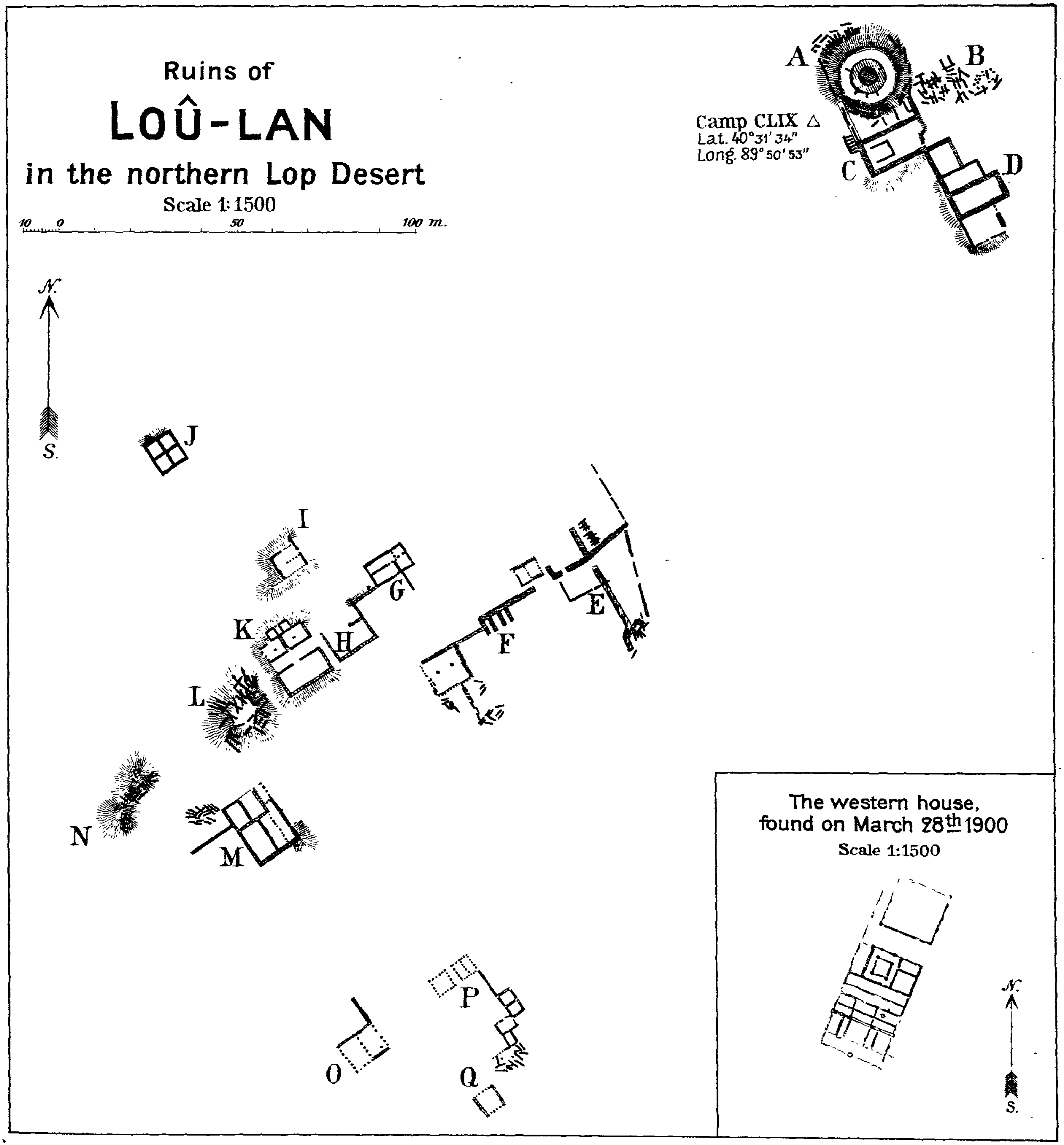


Fig. 289. FRAGMENTS OF WOOD-ORNAMENTATION.

The complex D consists of four houses standing immediately side by side. Their common façade extends from N. 27° W. to S. 27° E., and is 21.8 m. long. The first house is a small square apartment, the outlines of which were revealed by the kamisch sheaves built up horizontally. The second also forms a quadrilateral, and its ground-work on two sides consisted of horizontal beams. This house abuts on the south-south-east upon the house shown in Pl. 68, the dimensions of this last being 15.2 m. by 4.8 m.; it was divided into two rooms by means of a partition of vertical poles, and was connected with its neighbours on both sides by doors, the positions of two of which were distinctly traceable. The last house again is square, its sides measuring 8.4 m.; the side next the façade is marked by a massive beam. On the slope of the mound below the façade drift-sand has again accumulated, though the amount is small. The side facing the south-south-east consists of poles, some lying on the ground, others standing on end; the side looking towards the east-north-east was built of the same materials as the adjacent large house. In the latter wall is a door-space 1.3 m. wide.

At 300 m. N. 50° E. from the large house of complex D we observed traces of a foundation-wall of burnt clay, and at 185 m. S. 85° E. from the same yet other similar traces were found. At 97 m. S. 15° E. from the south-east corner of the last house in complex D there is a small heap of beams on a platform, which is connected with that on which the complexes E and F are built. Between this large mound and the mound on which stand the tower and the houses B, C, and D is



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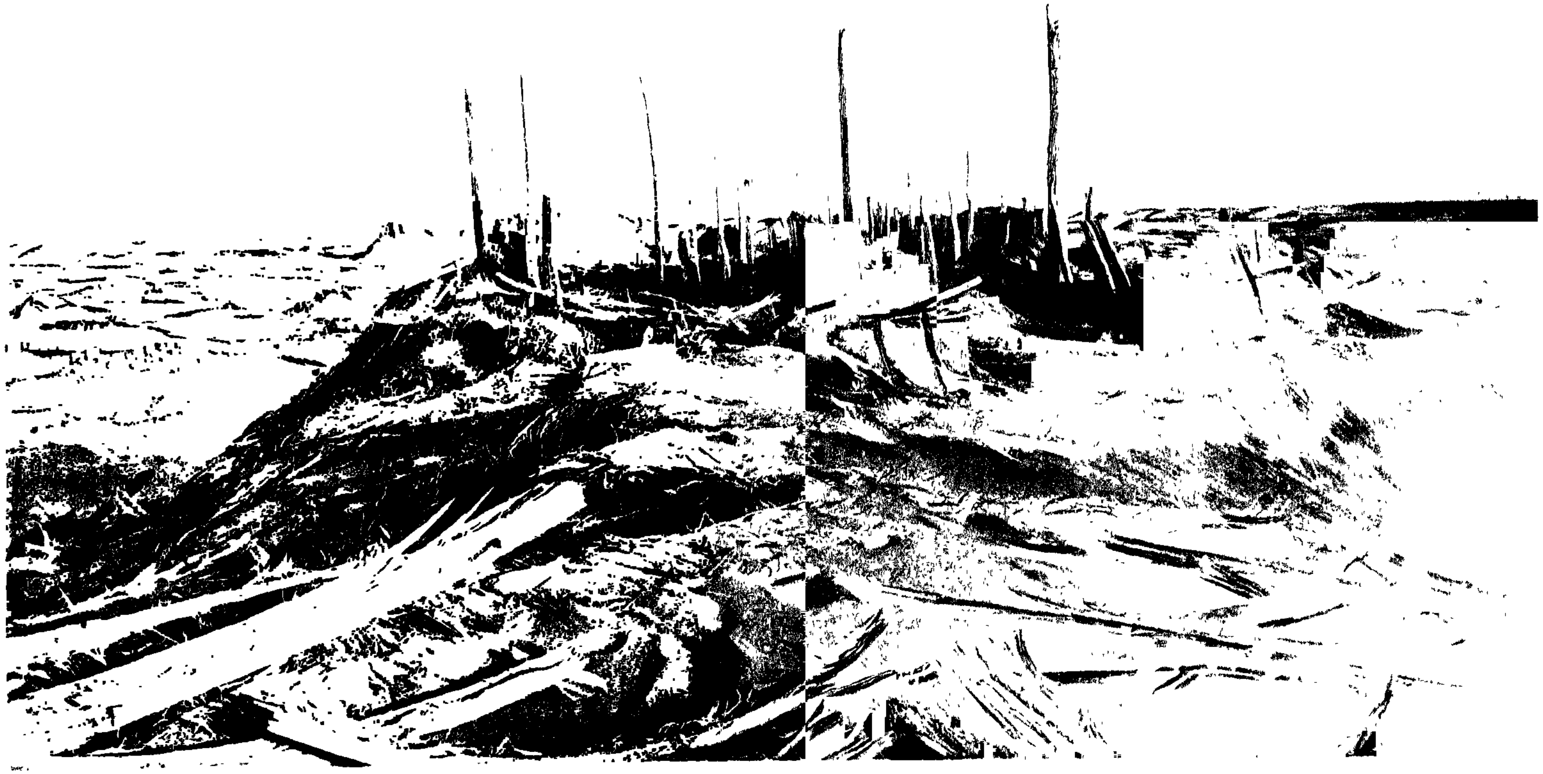
▙ *Clay* | *Prostrate beams* ⋮ *Upright beams (posts)* ▤ *Horizontal bundles of kamisch*

Pl. 68.



*Ljustr. A. B. Lagrelius & Westphal.*

HOUSE D LOOKING SOUTH-SOUTH-EAST.

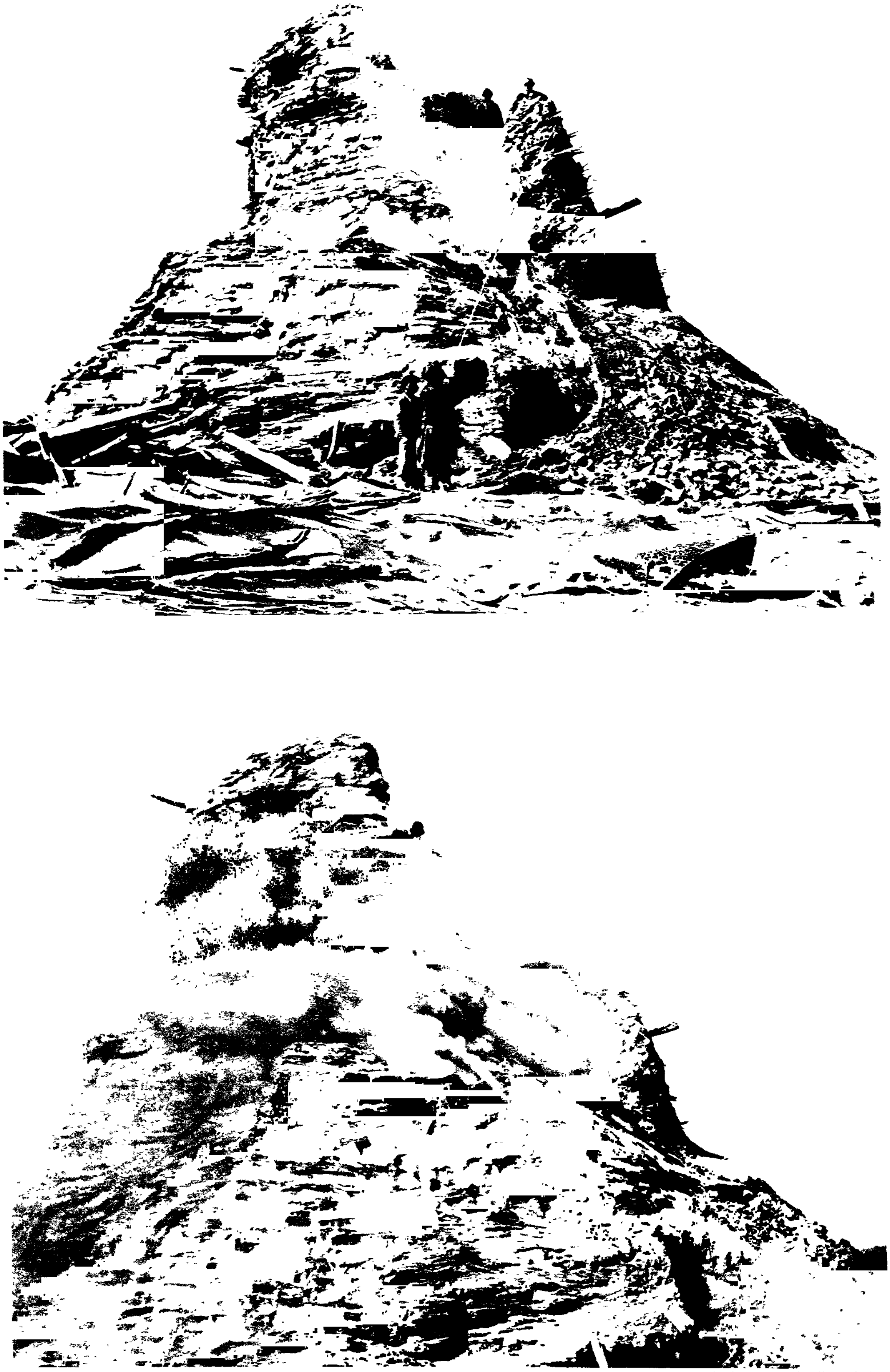
a hollow 2 to 3 m. deep and extending from N. 70° E. to S. 70° W.; on the souht it is bordered by the sharp-cut wind-eroded face of the larger platform. The three houses I have mentioned, standing at a considerable distance from the main portion of the village, appear to point to the existence of scattered dwellings, and I have no doubt that a more thorough search than that I was able to devote to the site would result in the discovery of several other houses. The topography of the village would appear in fact to have closely resembled the plan which is still customary in the towns and villages of East Turkestan, and their environs; that is to say, a central nucleus with the houses and offices of the officials, the caravanserais, and bazaars, while scattered round about in the environs are detached groups of buildings and homesteads separated from one another by orchards and cultivated fields. That we failed to discover amongst these ruins any traces of similar cultivation was of course not to be expected, for the surface of the earth has there been literally planed down and swept away by the wind.

From the southern corner of complex D to the nearest northern corner of complex E, in a direction S. 60° W., is 120 m. The ground-plan of the latter complex is more irregular than that of the former. First, we may distinguish an irregular four-sided structure, or apartment, the north-western wall of which was entirely missing. This is rather strange, for that side must have been far less exposed to the wind than, for instance, the east walls in complex D. Of the other three walls one, 19.6 m. long, was indicated by foundation-beams resting on the ground, while the other two were constructed of sun-dried clay. The one looking south-east was 13.8 m. long, and the other, facing south-west, 8.4 m. In the interior of this apartment was a heap of beams more or less split and cracked; here again the rule held good, that the portions of the timber which lie underground are the best preserved, in fact they were often quite uninjured. To the south-west of this apartment there occurred another, similar to it, though its clay walls only in part survived. The wall that faces south-east was 11 m. long and had a narrow door-way; two or three small side-posts would appear to have lent it greater support. Approximately as a continuation of the partition-wall between the two rooms a similar clay wall ran towards the S. 30° E., and was 20.3 m. long; a heap of poles and planks at its south-east end bore witness that a house had collapsed there. North-east of this same wall a similar wall, 25.7 m. long and constructed of beams and sheaves of kamisch, ran to the S. 15° E., and thus was not parallel with the first wall. South-west of the clay wall were the outlines of a rectangular apartment of huge horizontal beams.

Between complex E and complex F, and to the north-west, stands a small house, measuring 6.6 and 5.4 m., and divided into two rooms. Its walls consist of poles and posts partly horizontal, partly standing vertically upright. A pretty big heap of coal inside it seemed to point to its having been a smithy.

The house that stands farthest north in complex F proved to be the most interesting and the most remarkable of all. Its principal wall forms a continuation of the longest clay wall in complex E, and consequently extends from N. 60° E. to S. 60° W. From it project four smaller walls towards the south-east. From the south-east corner of complex E to the first cross-wall is a distance of 15.6 m. The portion of the long wall from which these four cross-walls project is 6.8 m. in length, Between the cross-walls are three stalls, which at the first glance suggested a stable or a temple shrine for images of Buddha. The walls were 1.95 m. high at the most, but on the top were so irregular that in places they actually appeared to have been filed away by the wind. They were 0.85 m. thick, and extended 5.6 m. from the principal wall. It was in the stall that lay farthest towards the north-east, and which had a breadth of 1.40 m., that we discovered all the fragments of written paper and tablets of wood which Mr. Himly and Prof. Conrady have deciphered and described. They were buried under an accumulated layer of dust and sand, not more than 1.1 m. deep, the spot being almost completely sheltered from the wind. The only side on which the stall was open was the south-south-east, and from that direction it seems practically never to blow in the Desert of Lop, at all events the wind from that quarter is only slight. The sand and dust having been whirled into the corner of this stall were unable to get out again, and it is to this circumstance that we must ascribe the fact that the fragments of paper showed not the slightest signs of wear or scouring by the sand, but were as well preserved as if they had lain there only a few days. Nor did the paper show any but the slightest signs of the «tooth of time», a circumstance that could only happen in a country where there is no rainfall, and where the atmospheric moisture is at a minimum. The fact of these scraps of paper lying at a depth of about one meter would make them hardly sensible of the alternations of temperature between day and night. Between winter and summer there is a greater range of temperature, but the changes are distributed over longer periods and are never abrupt. Thus it was the shape of the apartment, its orientation, its still surviving walls which, in conjunction with the protecting layer of sand and dust, had preserved these precious, though alas too few, documents from destruction, although this fate has overtaken all other perishable objects that may chance to have lain in the wooden house.

The layer of sand from which we unearthed these documents bore a striking resemblance to a rubbish-heap. I need hardly say that the contents of the stall were sifted to the very last grain of sand, until we came in fact to the hard bare ground underneath, and had literally cleared out the whole of the interior. Amongst the material thus removed we found the skeleton of a rat, with its skin scarcely injured; a great quantity of fish-bones — which witness just as unambiguously as the mollusc-shells do to the former presence of fresh water; a whip, with a loop in the end of its thong, and having the shin-bone of a sheep for the shaft; a pig's tooth; parts of the skeletons of sheep, cattle, horses, and camels; buttons; copper coins; rags of clothing; the sole of a shoe made of horse-hair; old iron, e. g. a rusty chain, a couple of holders for Chinese pencils; a wooden spoon; and finally a large quantity of kamisch-stalks. In a word it is little likely that all this worthless rubbish was brought there accidentally. The stall was indeed too small to have served as a dwelling. Possibly it may actually have been used as a receptacle for rubbish and sweepings of refuse. This is confirmed by the fact that most of the papers were fragments and had been deliberately torn to pieces. A large number of thin wooden tablets with Chinese script bore evidences of having been used twice, the face of the tablet with the first writing having been shaved off with a knife, after which the tablet was used a second time. The other particulars connected with this discovery are



*Ljustr A. B Lagrelius & Westphal*

PULLING DOWN A DANGEROUS MASS AT SIDE OF TOWER LOÛ-LAN.

given in Professor Conrady's discussion. I merely desired to describe the external circumstances amid which these documents were discovered. The other two stalls were of course subjected to an equally minute examination; they too were both filled with sand and dust to the depth of about one meter. In the middle stall however we found absolutely nothing, and in the south-western only two or three pieces of torn paper. It is quite possible that this clay house was provided with a roof of kamisch or planking, but that the stalls were open towards the south-east.

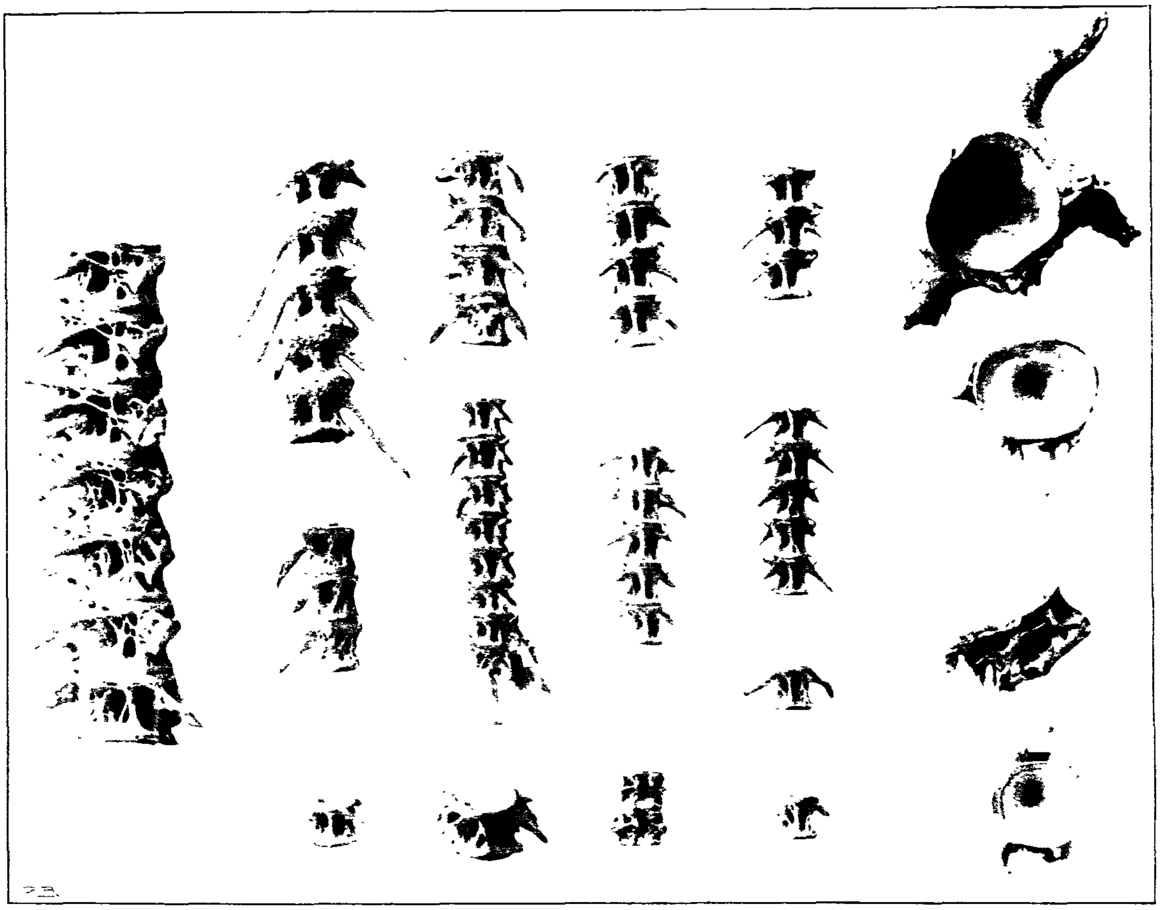


Fig. 290. SPECIMENS OF FISH-BONES FROM LÓU-LAN.

From the middle of the south-western cross-wall there projects towards the S. 60° W. a low and badly damaged clay wall 19.5 m. long, which again forms part of one side of a square house, the sides of which each measure 10.1 m. Two of its remaining sides consist of upright posts, the fourth side of kamisch sheaves arranged horizontally. Inside this house two bigger posts, as well as several of the side-posts, still stood upright. The tallest of these — in fact it was the tallest post of all those I measured on this site — is 4.30 m. high. It may indeed be called a remarkable fact, that timber posts which are exposed to such violent storms and to such severe abrasive action on the part of the wind should not only have been able to survive through so many centuries, but also in many cases should have preserved their sharp edges unimpaired. This applies especially to their upper parts, upon which the wind plays with much greater force than upon the parts near the surface of the ground.

In the interior of this house we hit upon a red clay earthenware jar, half buried under the sand. It is 70 cm. high and 65 cm. in diameter at its widest part, while the diameter of the opening at the top is 25 cm. It possesses no ears or handles, but close beside it we found a species of wicker basket with a strong handle, which had manifestly been used to transport the jar in.

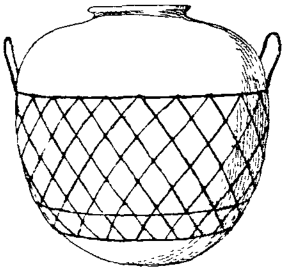


Fig. 291. HOW THE JAR WAS CARRIED.

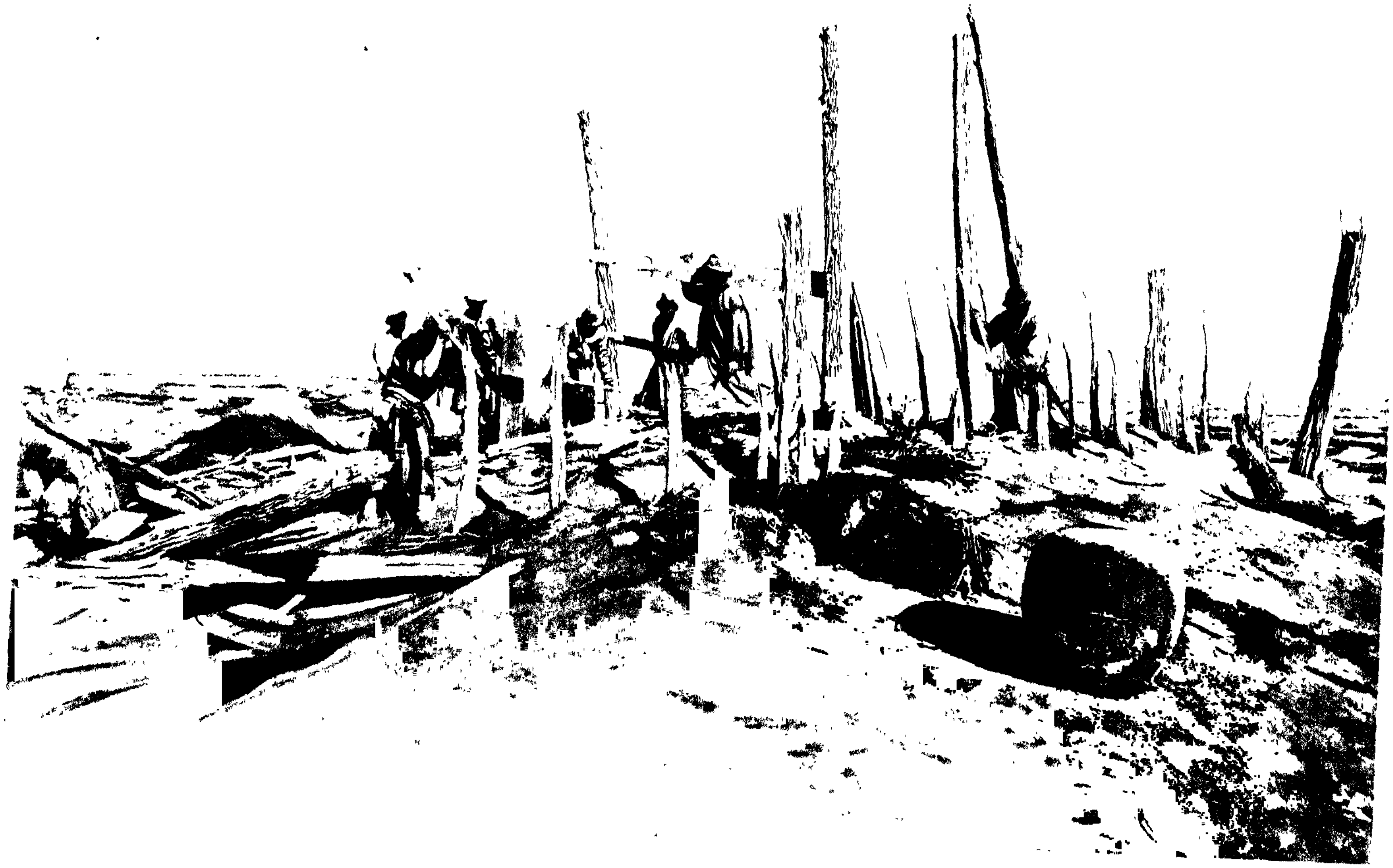
Amongst the sand on the leeward side of the platform on which this house stood we dug out a thick plank, upon which were carved a number of figures of Buddha, sitting each under a rounded arch, cross-legged upon a stool and with the hands folded upon the knees. The arches are supported by columns with decorated capitals, and between every pair of arches the half of a lotus flower is visible. Unfortunately this plank had for some time been exposed to the atmospheric influences, and all the finer details, which undoubtedly at one time existed, had been filed away and rounded off; nevertheless we took away with us the part of the beam containing four of the best preserved figures. We turned over the sandy slope and the interior of the house, but without finding any more similar wood-carvings; probably this plank had been fixed up inside the structure.

Nothing remains of the building which formerly stood south-east of this house except heaps of splintered beams and planks, and the original ground-plan could not be made out; though the débris form as it were a continuous series, stretching for 13.8 m. towards the S. 30° E.

The house G on my plan is rather small, measuring 11.8 m. by 6.3 m., and yet it was divided into four smaller apartments. Its walls consist partly of beams resting on the ground, partly of vertical posts, and partly of kamisch sheaves; from its south-east wall there projects at right angles a beam lying on the ground. The distance between the western corner of the MSS house and the eastern corner of the house G is 24.1 m., and their two platforms are separated from one another by a deep hollow, through which the wind sweeps unchecked.

The house H is not quite distinct, for we were able to trace out completely only three of its walls, measuring 8.15, 11.17, and 12.40 m. respectively. They consisted of vertical poles, of which nothing was left except fragments and broken ends.

At a distance of 16.9 m. to the N. 50° W. stands the house I, crowning its own detached little platform; it measures 11.80 m. by 9.33 m. The north-east wall is indicated by two beams lying on the ground with a doorway between them, and the other walls of horizontal kamisch sheaves and vertical poles. The two eastern walls project too far; possibly they point to the presence of yet a couple of other apartments, the outer walls of which have in that case been swept away. Between H and I too there is a deep wind-eroded hollow. And there is yet another similar hollow between the two small detached platforms on which stand the houses I and J. The ground-work of this last consists of four beams of exceptionally massive di-



Ljustr. A. B. Lagrelius & Westphal

HOUSE F. SOUTH-WEST OF MANUSCRIPT HOUSE. MEN EXCAVATING. IN FOREGROUND BIG EARTENWARE JAR

mensions, arranged four-square, while two others form a cross in the interior and divide the house into four small rooms. The sides measure 10.3 m. and 9 m. respectively. The neighbourhood to the west and south-west of this part of the village possesses a great abundance of toghraks, some of them still standing upright. The village occupied unquestionably a magnificent situation, with the reed-grown lake to the south and the forest to the west. It is from both these sources and from the ground itself that the building materials have been derived; the builders did not need to fetch their materials from any very great distance.

The house K exhibits a peculiar shape: on the whole it forms a rectangular structure, its sides measuring 14.35 m. and 15.80 m. respectively; but in the middle it would appear to have been divided by a passage-way, so that possibly there may have been two separate houses. The passage-way is closed at its western end by a fence of vertical poles. Three of the walls in the south-eastern half are built of the same materials, while the fourth, next the passage-way, consists of two horizontal beams with a doorway between them. The north-west half of the house consists of two rooms; in the middle of each of these stands an upright post. On the north-west side there appear to have been two square projections or verandahs; their foundation beams survive uninjured.

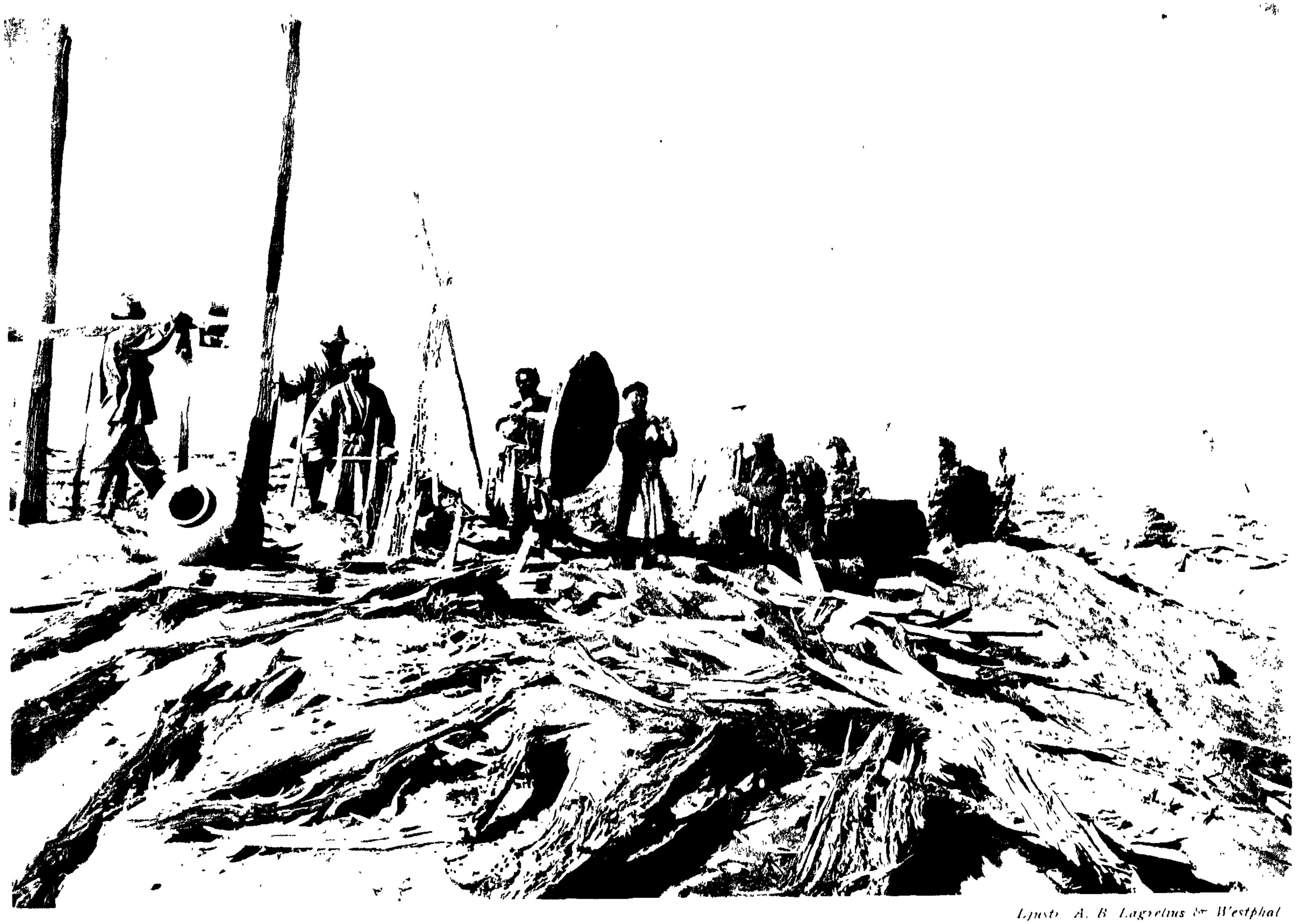
A detached platform to the west of K is crowned with the ruins of the house L, consisting of big beams lying in utter confusion. Here it was very easy to see how the timber protects against wind-erosion the ground upon which it lies, for the shape of the platform follows exactly the situation of the beams.

To the S. 20° W. lies at a distance of 25 m. the house M, a rectangular building with sides measuring 18.7 m. by 12.6 m., and extending from N. 35° W. to S. 35° E. It is divided into six rooms of different sizes and shapes. The walls consist partly of vertical posts, partly of horizontal kamisch sheaves, and partly of tamarisk faggots standing on end between the posts and supported by them, as may be distinctly seen in Pl. 72. The two side-posts and the lintel of three of the doorways are still standing, and in one of them the door itself still hangs. It is made of vertical planks and stands wide-open, though half embedded in the sand, a small quantity of which has collected in the interior of the house. From the south-western wall projects at right angles a wall made of horizontal kamisch sheaves. Possibly this may have had some sort of connection with the three confused heaps of beams N, which lie to the north-west of it. From the southern corner of the house M it is 45 m. in a direction S. 35° E. to the end of a wall, 8 m. long, which consists of horizontal bundles of kamisch, and which in its turn runs from the house O. This house is 10.15 m. long, and is divided into two rooms, while its walls consist for the most part of vertical posts. North-east of this again stand two small rectangular houses, with walls 5.5 m. long, constructed of vertical posts. The complex Q, to the south-east of it, consists of five very small houses, huts, or booths. But beyond them to the south we failed to discover any further traces of houses; whence we may infer that the complex Q stood immediately on the shore of the lake.

This, then, is the way in which the ruins of Lôu-lan lie with respect to one another. The ground-plan of the village is peculiar, in that there is no main street flanked by rows of houses such as we should expect on the great caravan-road leading to Tung-chuan. But this road probably passed close to the tower (A), and left the main portion of the village to the south. Between A and J there was an open space, a sort of market-square, in which probably markets used to be held. There is no trace of any bazaar; but it is not improbable that the stalls and shops may have been grouped around the tower, which was no doubt the most conspicuous centre of the locality. Nor did we perceive any traces of either cultivated fields or gardens, though the discovery of wheat and wheat straw in the MSS building suggest that agriculture was possibly carried on here. Had there been no straw, it would have been easy to suppose that the corn had been brought thither from Tung-chuan, Turfan, Kara-schahr, or Korla. But certain of the MSS make it abundantly clear that agriculture was carried on here. The fields were no doubt irrigated by means of canals led from the lowest part of the Kuruk-darja. We discovered neither a burial-place nor any skeleton remains of human beings. Any Chinese who died here would no doubt have, as they always have in East Turkestan at the present day, a sum of money laid by sufficient to transport the body to China proper. Nor did we find Mongolian or Muhamedan graves either; but then the date which Mr. Himly assigns to the documents discovered makes it *impossible* that there could have been the last-named; the place was in all probability deserted before the era of Muhamed.

There are evident differences both in the style of the houses and in the care with which they were built. The best of the timber houses are D and M, and these are also the best preserved. Here I measured foundation beams having dimensions of 6 m. × 0.34 m. × 0.21 m., and there were others even bigger, though more cracked. The way in which the vertical posts are morticed into the foundation beams is exhibited in the accompanying fig. 281. There were no fragments to justify an inference as to the shape of the roofs; but we may take it, that these were in most cases horizontal, as they often are in the houses in the Chinese villages of Kan-su. The less solidly constructed houses, in which kamisch formed an integral material, probably in part belonged to the humbler villagers and in part were stables, sheepfolds, and outhouses, while the more pretentious dwellings would belong to Chinese officials and merchants, as well as to the post-horse keepers who maintained the traffic to Tung-chuan, provided travellers with carts and horses, and transmitted the post. The clay walls that survive point also to larger structures, and probably they may have been employed to support an upper timber storey with a turned up roof.

Pl. 71.



*Ljustr A. B Lagrelius & Westphal*

ANOTHER VIEW OF HOUSE F.

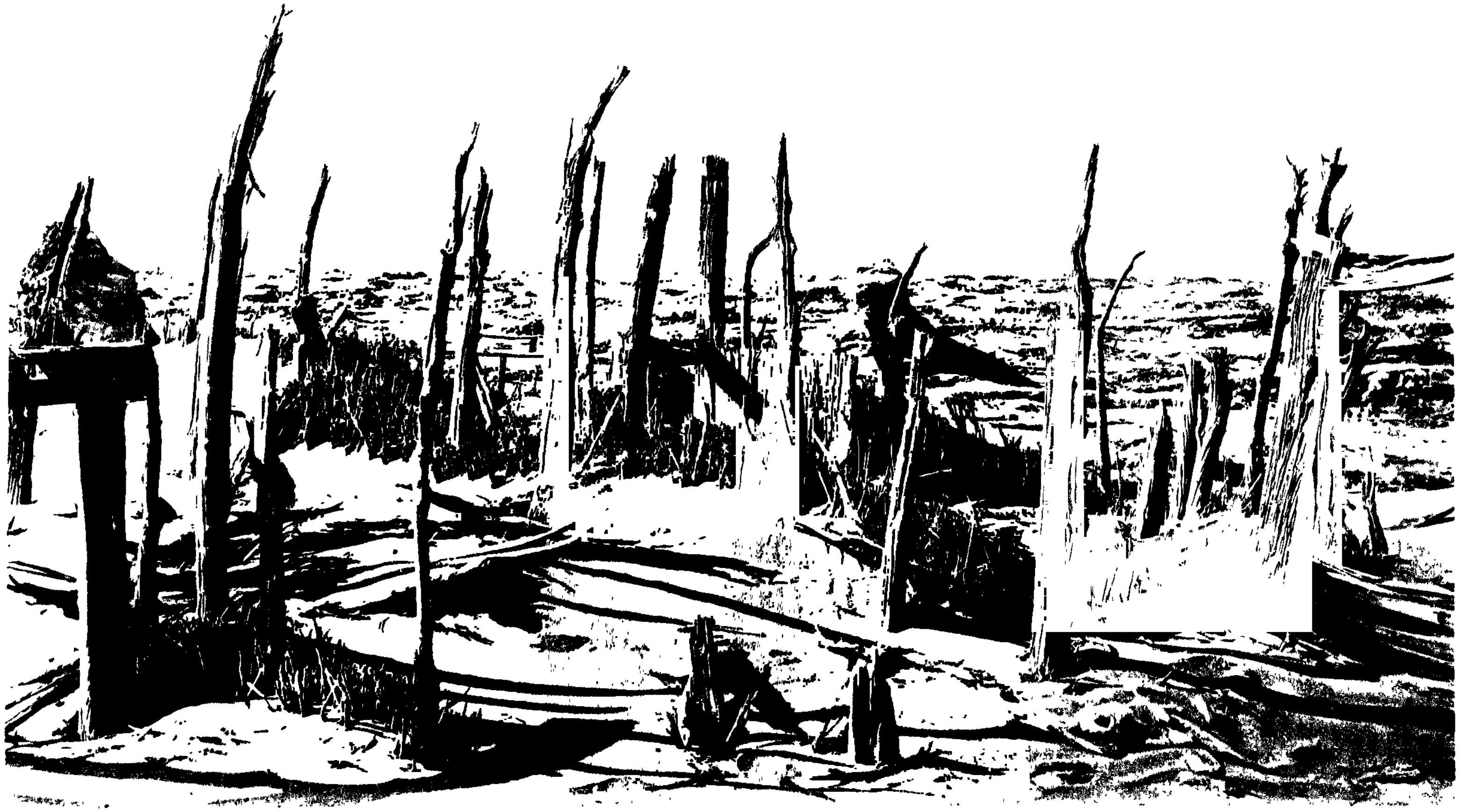
On right manuscript house and tower at camp CLIX.

# CHAPTER XLV.

## TOWERS, WOOD-CARVINGS ETC. OF LÔU-LAN.

What at the first sight cannot fail to arrest attention is the great difference that exists between these old villages and places and those that stand beside the Kara-koschun. The former were in every respect more solidly built and more populous, and for a long period were not moved from their sites; the latter on the other hand are fragile, temporary kamisch huts, which have to be abandoned repeatedly time after time in consequence of the instability in the distribution of the water. In all the Kara-koschun area there does not exist at the present day a single dwelling that in point of solidity can be compared with any even of the more modest of the timber houses of Lôu-lan. The only modern place that has houses equally as solid is Tscharklik, but it lies outside of the Kara-koschun region. The road which once ran through Lôu-lan was, in respect of traffic, as a means of communication, and as a highway for the passage of troops, unquestionably far more important than is now the southern caravan-route of East Turkestan. Upon the strength of one of the documents I discovered, as also by analogy, we may safely state, that there formerly stood on the shores of Lop-nor huts as ephemeral as the kamisch huts that now stand beside the Kara-koschun. That fishing was there carried on is evidenced by the great abundance of fish-bones. No doubt the people possessed boats from which they carried on their fishing, and the fishermen will have dwelt in temporary huts erected close beside the lake. But all traces of them have completely disappeared; indeed it would be surprising if they had not, for such slight and perishable structures would be quite unable to withstand the storms of centuries.

The clay tower (A on the plan) rises 8.8 m. above the top of the wind-eroded platform or mound on which it stands, and is visible to a great distance across the flat Desert of Lop. At its base it has a circumference of 49.80 m. It is however difficult to make out what its ground-plan is, owing to the heaps of soft grey material which have fallen off it and now lie heaped up against it all round. Indeed its general shape has been distorted by the weather. Certain of its external features appear to suggest that it was constructed in two stories, the lower one cubical, the upper cylindrical, though with regard to this I am unable to speak decisively. There seems however to have been a sort of platform about 3 m. up from the ground. The material of which it is constructed is sun-dried brick, of the same kind as that still employed in the country; that is to say the bricks were prepared by being pressed into a square hollow wooden mould, and then taken out and dried in the sun. The skeleton of the tower consists of separate series of beams and posts arranged horizontally, radially, and concentrically, thus materially strengthening the structure. In places the radial beams project fully a meter beyond the wall of the tower. Faggots too placed horizontally were also employed as building material. At the bottom of the tower the bricks for a depth of 3 dm. are coloured red; these consist of thin tiles measuring 20 × 25 cm. A closer examination revealed that they are as soft and brittle as the sun-dried bricks, and consequently very different in point of quality from those we found at the three detached houses. It may be that red was the natural colour of the deposit from which the clay was obtained; it may be also that the bricks were only insufficiently burned. At the very top of the tower there is another similar belt of red tiling, together with some charcoal, showing that a fire had been made on the summit. Very likely this was kindled by a post keeping watch on the tower at some troublous period, when the approach of a hostile force would be announced to the inhabitants by means of signal fires. But it is difficult to make out satisfactorily what purpose it was these towers served. Their irregular positions preclude us from looking upon them as *potajs* of the kind that we find at the present day on the road between Kaschgar and Chotan. Nor may we assume that the tower A (say) is the last surviving portion of a former town-wall of Lôu-lan, the rest of which has disappeared, for if that were the case, we should surely have been able to discover yet other fragments or traces of the wall. It may be said that as a rule there was a tower beside each village, and the most obvious and natural explanation of its purpose is to suppose that it served as the outlook and watch-tower of the inhabitants. If, for example, a fire were lighted on the tower of the village that lay farthest east, it would be at once observed from the other towers, and the entire country would be simultaneously warned of the approach of danger and could prepare to defend ilself. This seems to me more probable than any other explanation. When I visited the place I did indeed wonder whether the tower might not be a *stupa* of the kind that is found in other parts of East Turkestan, like those, for instance, which Stein describes. An examination which I began into the interior structure of the tower led however to no positive result. After pulling down two or three pieces of wall that threatened to fall in upon us, we excavated a sort of well 2 m. deep down into the body of the tower, but it was solid throughout; nor could we perceive anything that looked like an entrance, or an interior stairway, or apertures in the side. The impression left upon me was that the tower had been built solely for the purpose of commanding a wide prospect over the tops of the highest trees of the poplar forests in the locality, for these were the sole obstacles to see over in that extraordinarily flat country, where even undulations of the surface do not exist. And how vastly different the view which then presented itself from the summit of that watch-tower from the scene which meets the eye at the present day! Then the country was dotted with lively villages, an active traffic rolled along the great highway, and there were green forests, waving fields of kamisch, and wide expanses of



*Ljust. A. B. Lagrelius & Westphal.*

HOUSE M, GIVING AN EXCELLENT IDEA OF HOW THESE BUILDINGS AT LOÛ-LAN WERE CONSTRUCTED OF POPLARS AND SHEAVES OF KAMISCH AND TAMARISK STANDING ON END.

In the very middle is a door set wide open; the whole of the door-frame is intact, though half buried in sand. On left doorway without door. In foreground a thin layer of sand which has gathered on the sheltered side of house. In background extensive view across jardang desert.

blue water. Now there is nothing but one vast sweep of greyish-yellow, barren, desolate, arid desert. And yet to one who has studied the Lop-nor problem as earnestly as I have done, it is a scene not devoid of sublimity; the work which for century upon century the winds and the storms have been accomplishing lie spread out like a map before our very eyes. All the countless jardangs and table-like elevations of the surface stand out on the picture with extraordinary regularity and distinctness, and between them the parallel wind-eroded gullies stretch away as far as the horizon in every direction. Of the Kuruk-tagh close at hand not a single mountain was visible, because at that season the atmosphere was constantly charged with fine dust. Standing on the top of the tower, one finds oneself the centre of a wilderness of yellow clay, appalling in its monotony.

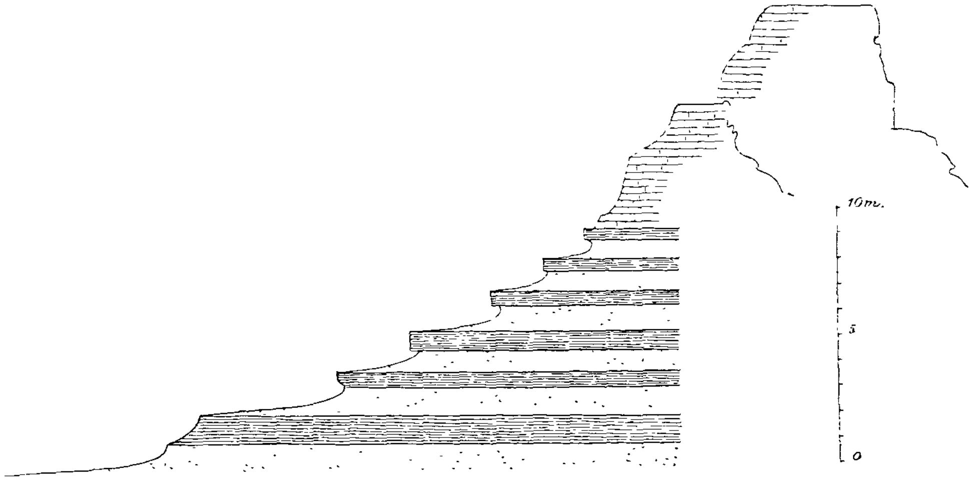


Fig. 292.

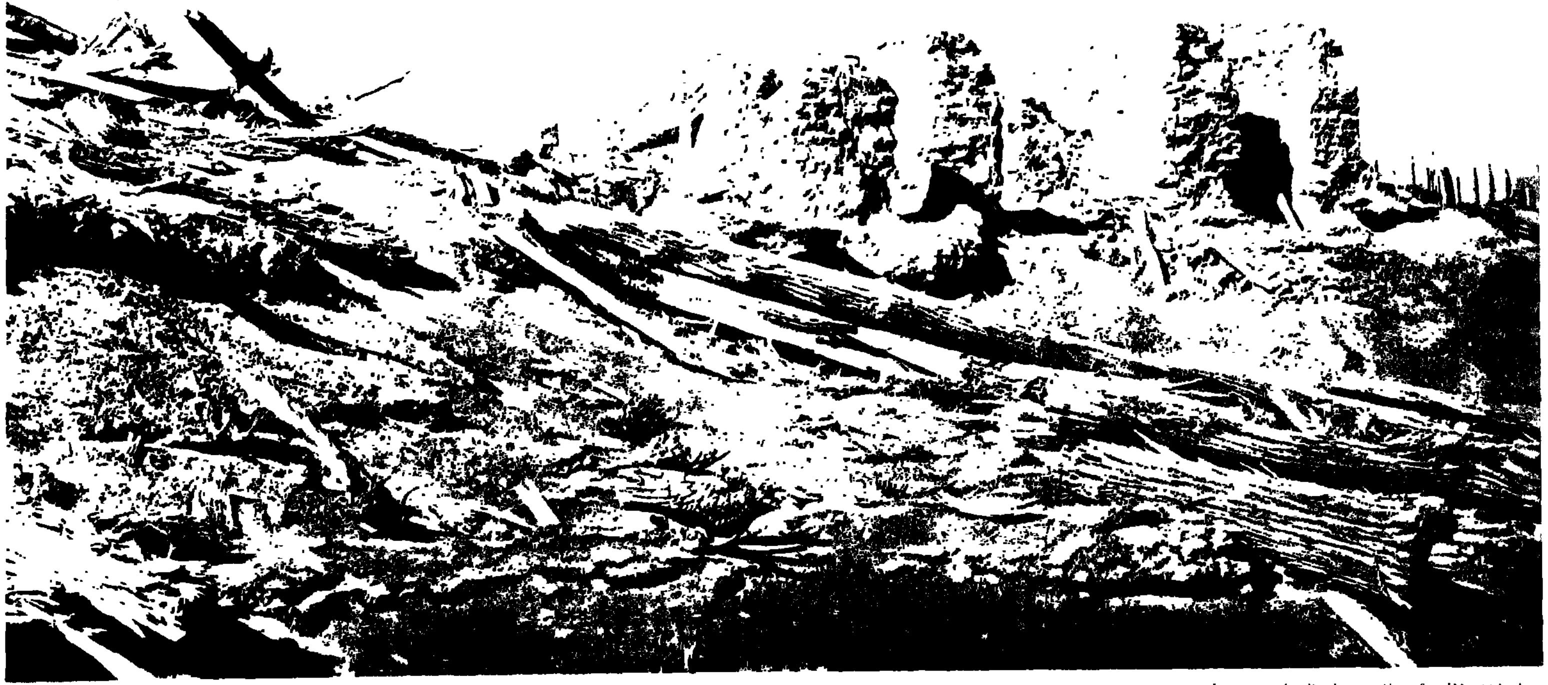
The above fig. (292) gives a profile of the tower and the platform on which it stands. The latter is 9.6 m. high, so that when the tower is looked at from the bottom of the depression on its western side, it appears to be twice the height it actually is, and so when seen from the north and the north-east. On the south-east and south the platform is not broken down, but connects with the platforms that support the houses B, C, and D; so that when it is viewed from that direction, the tower appears to be a good deal lower.

On its western face, where there is no timber, the profile of the platform can be beautifully seen. Six different layers or bands of hard clay material, with vertical edges, project here after the manner of cornices, and are separated by layers of sand, which shelve down from one clay band to another. The heights from the bottom of the depression to the upper edge of each clay layer successively are —

| | |
|---|---|
| Layer 1 | 1.6 m. |
| » 2 | 3.2 » |
| » 3 | 4.8 » |
| » 4 | 6.4 |
| » 5 | 8.0 » |
| » 6 | 9.6 » |

In another part of this volume I have given an analysis of the contents of each of these layers (see p. 468 above). I will therefore only add here the results of the preliminary examination which I carried out on the spot. The different layers are to some extent shown on Pl. 65.

Layer 1, the lowest level in our profile, is 107 cm. thick, and consists of fine, yellow clay, without any discernible organic traces — no mollusc-shells. Layer 2 is 55 cm. thick and consists of the same fine dusty clay, in places alternated with very thin layers of sand. At intervals it is interpenetrated by the roots of plants; no mollusc-shells were found. Layer 3 is 75 cm. thick and contains remains of plants, especially roots of kamisch, as also mollusc-shells. The same characteristics are repeated in layer 4, which is 52 cm. thick, though both the vegetable remains and the mollusc-shells are more numerous. Layer 5 is 40 cm. thick and contains numerous organic remains. The top layer, 6, upon which the tower stands, contains an abundance of mollusc-shells and plant remains. This layer too is about 40 cm.: thick Thus, taken altogether, these layers of clay have a thickness of 3.69 m.; the intervening sand reaches therefore a total thickness of 5.91 m. At different periods alternate layers of sand and clay have thus been deposited on the bottom of a large lake, a lake that was considerably older than the historical Lop-nor. At the time when the tower was built the youngest or uppermost layer was firm ground, and the northern shore of the lake of Lop-nor was to the south of the tower. The regular, horizontal character of the deposits and the mollusc-shells prove that the former were laid down as sediment in a freshwater lake. But the absence of organic remains in the two lowest layers seems to point to a lake with salt water. It is quite easy to imagine the local changes which would cause this salinity: it can only have been caused by an alteration in a river-mouth or by the cutting off of a portion of the lake. But the laying down of a sedimentary deposit to the thickness of 9.6 m. under the circumstances that now prevail would obviously require a very long period of time. The regularity in the alternation of the clay and sand layers points unmistakably to a periodicity in the lake or in the river. One might suppose that the lake, which at that time extended a considerable distance north of Lôu-lan, used sometimes to contract, whereupon a sandy deposit would spread itself over the clay sediment. This would be followed by a further expansion of the lake, and that would give rise to the formation of a fresh deposit of clay — a transgression in miniature. There is however yet another way of explaining the pronounced character of the alternation of layers, namely by changes in the lowermost course of the river. If for instance, just before discharging into the lake, the river traversed a reed-grown basin, the water would there be relieved of all its sediment and would issue into the principal lake clear and bright. During a period such as that it would be mainly drift-sand that would settle on the bottom of the lake, that is to say in the particular part of the lake we are considering, which in all probability was not very far distant from the shore, for no sand has been able to travel as far as the central parts of the lake. After the reed-grown expansion became filled with mud or after the river changed its course, its water would enter the lake charged with sediment, and so the mud or clay deposits would again secure the upper hand. Sand does of course occur in the clay deposits and



Ljustr A B Lagrelius & Westphal

HOUSE OF SUN-DRIED BRICKS IN LOÛ-LAN, IN THIRD SECTION OF WHICH, FARTHEST ON RIGHT,
ALL THE OLD CHINESE MANUSCRIPTS WERE FOUND.

clay in the sand deposits; but in the former case the clay is decidedly predominant and in the latter the sand.

On 7th March we tramped on foot 14 km. towards the north-west, passing immediately south of the tower of the 3rd March, then crossing, twice, our route of the same date, and passing the three small houses with the brick foundations. Immediately south-east of this little village or steading we came upon another clay tower, in a state of ruinous decay, which we did not see on the former occasion because of its great resemblance to an ordinary clay mound or jardang. Here again, then, we have a village protected by a watch-tower. It is true, we found no ruins of houses beside the tower of the 3rd March; but the existence of the tower bears eloquent witness to the former existence of a village, which has now completely disappeared. Yet we did observe a solitary beam or two now here, now there, all soft and crumbling to pieces, the last lingering remains of ruined houses. My men, who were regularly scouring the entire neighbourhood in search of ruins, several times reported the existence of similar beams, but they were always insufficient to warrant any further inferences being deduced from them. One of my Cossacks had discovered however, some kilometers north-west of the village with the three detached brick houses, a solitary small house, but we were now unable to find it again. Without a clay tower to serve as a beacon it is impossible in that flat region to find again any definite, fixed point which has been touched on on a previous journey. The clay mounds look like walls, groups of standing poplars like the vertical posts of houses; you are deceived and disappointed time after time.

To travel to the north-west in a country like that is in the highest degree tiring and trying to the patience, for you have to cross up over each successive jardang and down over each successive wind-eroded gully, and have to tack backwards and forwards repeatedly to get on at all. The poplars that still remain standing form groups and rows, stretching in exactly the same direction that they do beside the Tarim and its lakes; but it is impossible to trace out any sure boundary-line for the former lake by means of them. In most cases it is impossible to make out on which side of them the water extended. In some places the kamisch is extraordinarily abundant, forming a thick, shaggy carpet. The stalks are seldom more than 1 to 2 dm. high, and are crammed full of sand and salt, and burst at a touch. The leaves on the other hand are often fairly pliant. The vegetation here is always on the elevated portions of the desert, as it is in those parts which have been already described.

At length we reached our own camping-ground of the year before, and were easily able to convince ourselves that the clay towers which we had then seen were the same as those we had just visited. Two or three kilometers farther on we came to another village, which one of my men had lighted upon. This proved to be especially interesting. Generally speaking the work of destruction had advanced farther here than at the village where we encamped, and from such fragmentary ruins as remain it was difficult to make out how many houses there had been; perhaps there were eight, perhaps more. Three of them are however well preserved, and I was able to measure them.

This village, like that where we encamped, extended in a long line towards the south-west, the direction in which the prevailing wind blows, and begins with a tower, though one of insignificant dimensions. Its circumference is 22.3 m. and its height 2.65 m., its shape being that of a cube resting on a wind-modelled platform, (see the upper photograph on Pl. 74). Sixty-three meters to the west of it stands a wall 9.82 m. long, or rather it is a palisaded fence of withies and brushwood, and stretches N. 52° W. From its western end it is 240 m. to the north corner of the house C. (Pl. 75), which, in conjunction with two others, appears to have formed a self-contained complex. The frame-work of all these houses consists of massive beams and posts, and also to some extent of vertical posts. The house C measures 17.6 m. by 8.7 m.; the house D, 7.45, 14.6, and 8.7 m.; the house B, 5.67 and 5.55 m. This last was undoubtedly the principal building, the other two forming its side-wings, and the three inclosed between temh a hollow square or court-yard, 30 m. long by 16 m. wide. The façades of the two wings, which face the south-east, lie along the same line and stretch towards the S. 58° W. The court-yard seems to have been shut in by a fence of palings, though it was no doubt pierced by an ornamental entrance-gate like those which are now used to distinguish a jamen or a temple. Apart from a few fragments all that remains of it are two immense posts prostrate on the ground. North of the houses B and C there is a wall or palisade, 3.75 m. long, which, like A, possibly served merely as a protection against the wind and the drift-sand, though it is more likely that it represents the last surviving portion of some outhouse or hut.

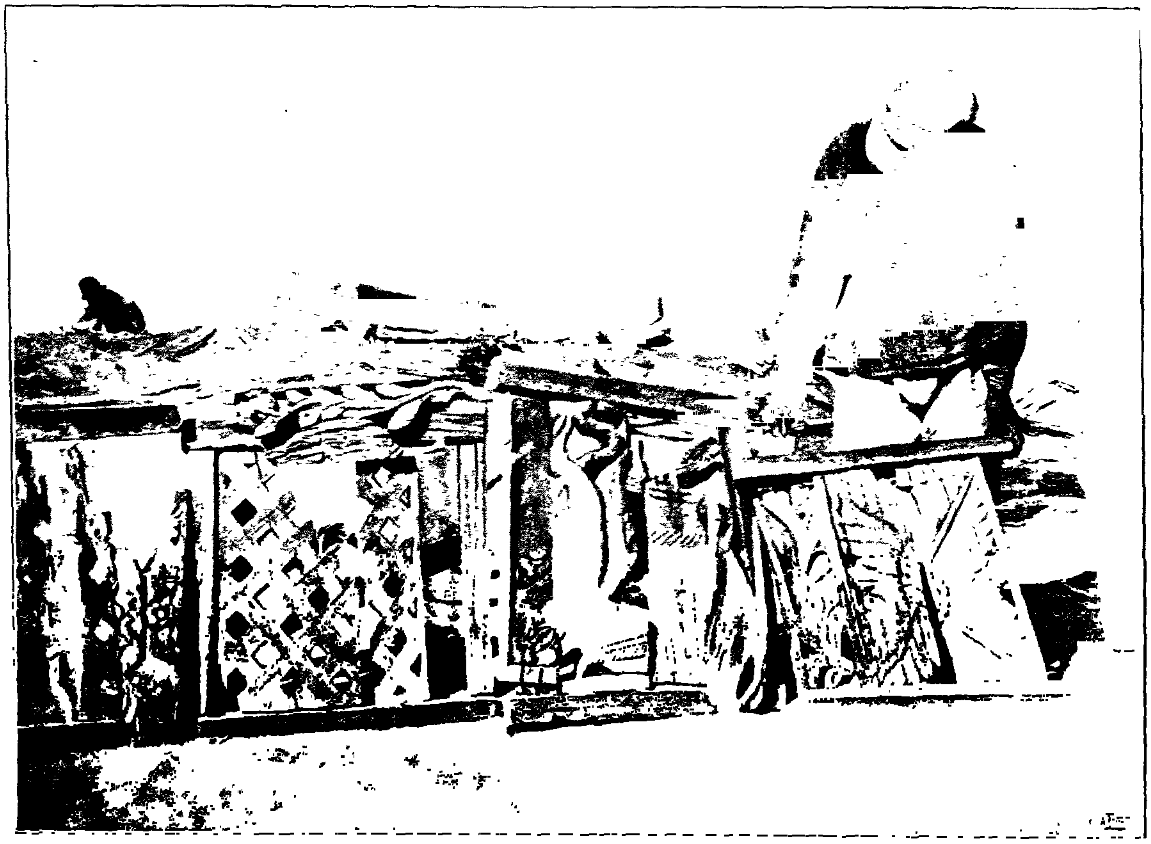
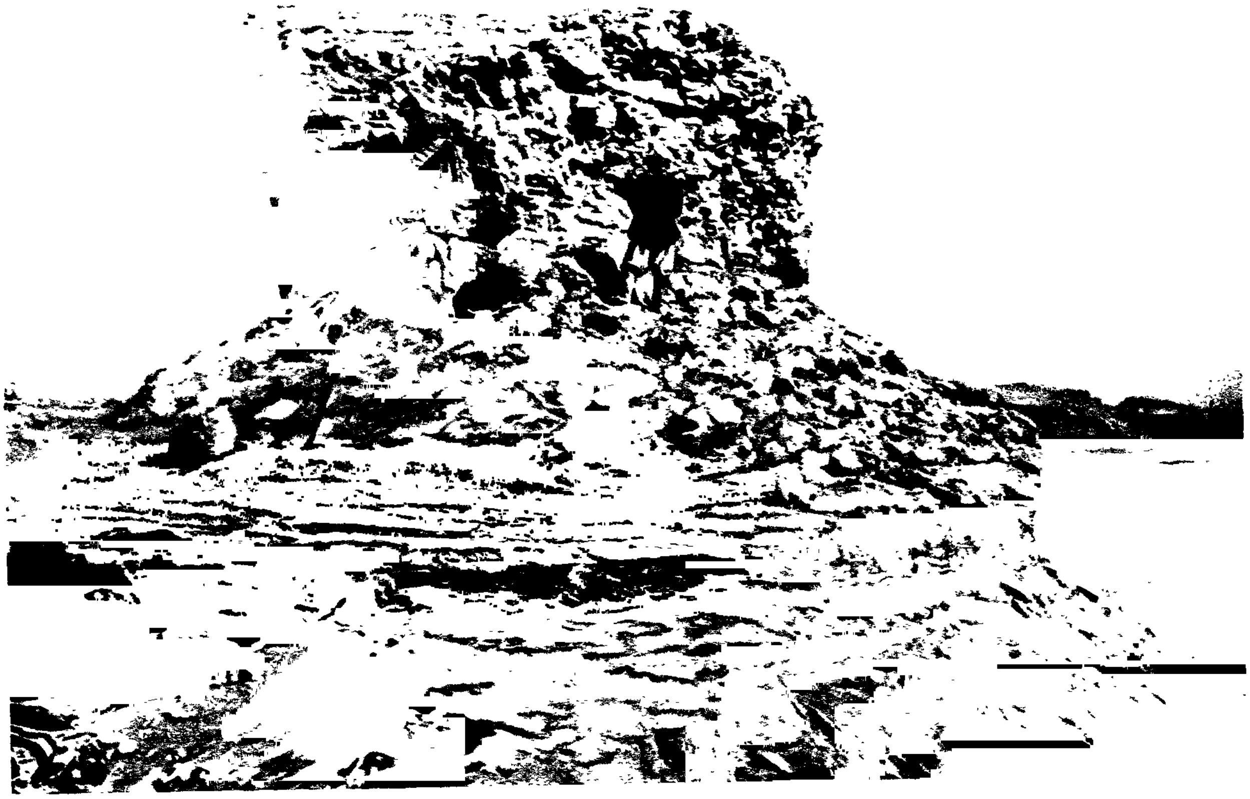


Fig. 293. WOOD-CARVINGS FROM HOUSE B.

Pl. 74.



TOWER OF MARCH 7TH

*Ljustr. A. B. Lagrelius & Westphal*

LARGEST HOUSE IN MOST NORTH-WESTERLY VILLAGE OF LOÛ-LAN. MARCH 7TH.

At the distance of 68 m. S. 42° W. from the house D there is another similar palisade, 13.1 m. long, and south-west of that again yet three others like it; the last of these had evidently been a small hut.

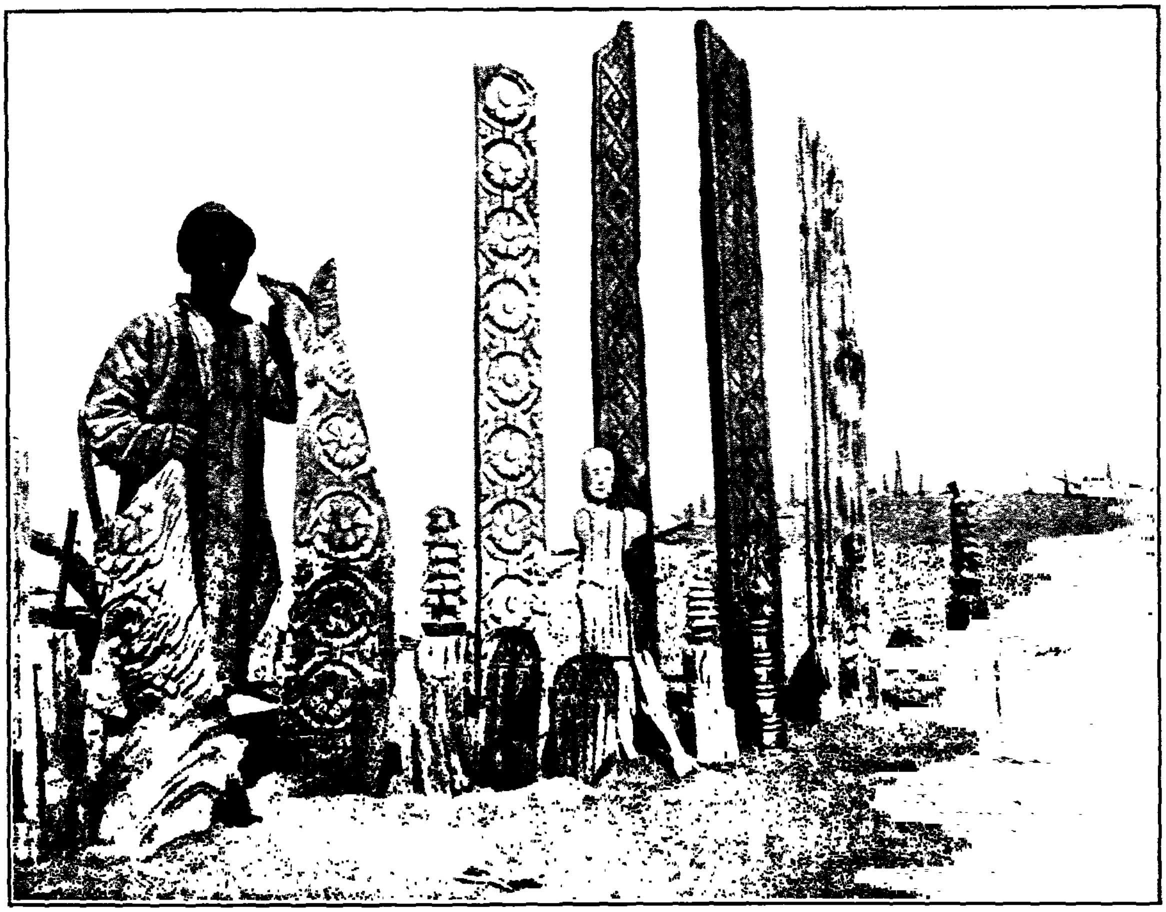


Fig. 294.

The little rectangular house B is especially interesting. As usual it stands upon a clay platform, and its foundations consist of four powerful beams. It was in this house that we found not only the greatest quantity, but also the most beautiful, of the wood-carvings in the entire area of the ruins. The devices consist for the most part of round lotus leaves and graceful floral arabesques of a conventional pattern. Besides these, we also discovered latticed windows of different geometrical patterns and figures, turned spirals and pinnacles; these no doubt once adorned the roof of the little house, which can hardly have been anything but a temple. Amongst the objects I brought away from this place is the wooden image of a man, which I took to be an image of Buddha, though Mr. Himly doubts this. It was probably only the frame-work, or rather the core, of a figure which was cased with some other material and painted. A few faint traces of red and white on some of the planks point to their having been painted as well. From the geographical point of view it was particularly interesting to find in two pieces of carving representations of fish interwoven amongst the floral arabesques; possibly these last may have been aquatic plants; the gill-slits as well as the scales near the tail are especially distinct. It may be pretty safely assumed, that the inhabitants of this place would never have thought of using fish as an essential motive in their decorative work had not fish played a prominent part in their means of sustenance, and been found in the immediate neighbourhood. In this respect these artificially carved fish may almost be regarded as a sort of »representative fossils«, which, even though we had discovered no fish-bones, mollusc-shells, or other proofs of the existence of a lake, would speak eloquently for the presence of collections of fresh water in the vicinity. But the discovery of fish-bones and of representations of fish puts it beyond all doubt, that the inhabitants of this locality lived in great part upon fish and used fish as food, just as the modern Lopliks do, but the modern Tibetans do not. The only difference was no doubt this, that whereas fish form the principal food of the Lopliks, agriculture and the keeping of live-stock were in Lôu-lan more important than fishing. But in spite of our most diligent search we never found any remains of canoes or other boats; but then any that may have been left by the lake-side would be exposed to more rapid destruction than the more resistant and solid houses.

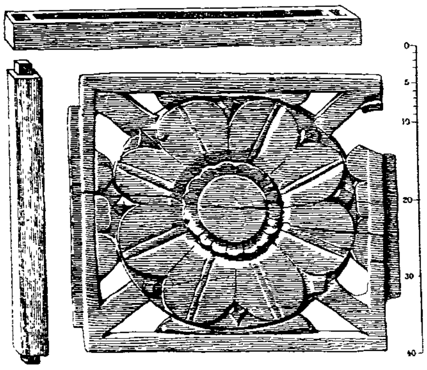


Fig. 295.

A large plank, 22 cm. in breadth, was carved from end to end with figures of men, each, like the seated figures at the village where we encamped, under an arch, and with distinct traces of an aureole or glory round each head*. Of this plank, which was unique of its kind, I brought away a specimen. Fragments of two smaller pieces of plank show a man sitting, the knees, crossed feet, and left hand being well preserved; the clothing is a good deal folded.

Upon comparing together the wood-carvings which we excavated it is speedily apparent that they fall into two different classes in respect of size. One class embraces strong planks 2½ m. long, the other thinner pieces 41 to 55 cm. long. The former class were affixed partly in a horizontal position, as cornices or panels, partly in a vertical position, for instance the planks with the human figures. These were however inclosed in square frames (see fig. 295), each frame containing a separate design, such as a large lotus flower with four or eight leaves, or an open-work pattern.

All the timber that lay on the outside of the heap of ruins was injured by the winds and the weather; the only portions that are in a good state of preservation are those that were covered with sand and dust (see by way of example the very fine detail shown on fig. 294).

Beyond the carvings we found nothing here except a red cord, which may have been used to hold together the beads of a rosary; a number of small primitive earthenware cups; a small slab similar to those which in Chinese and Tibetan temples are wont to be placed in front of the idols to arrange the sacrificial bowls

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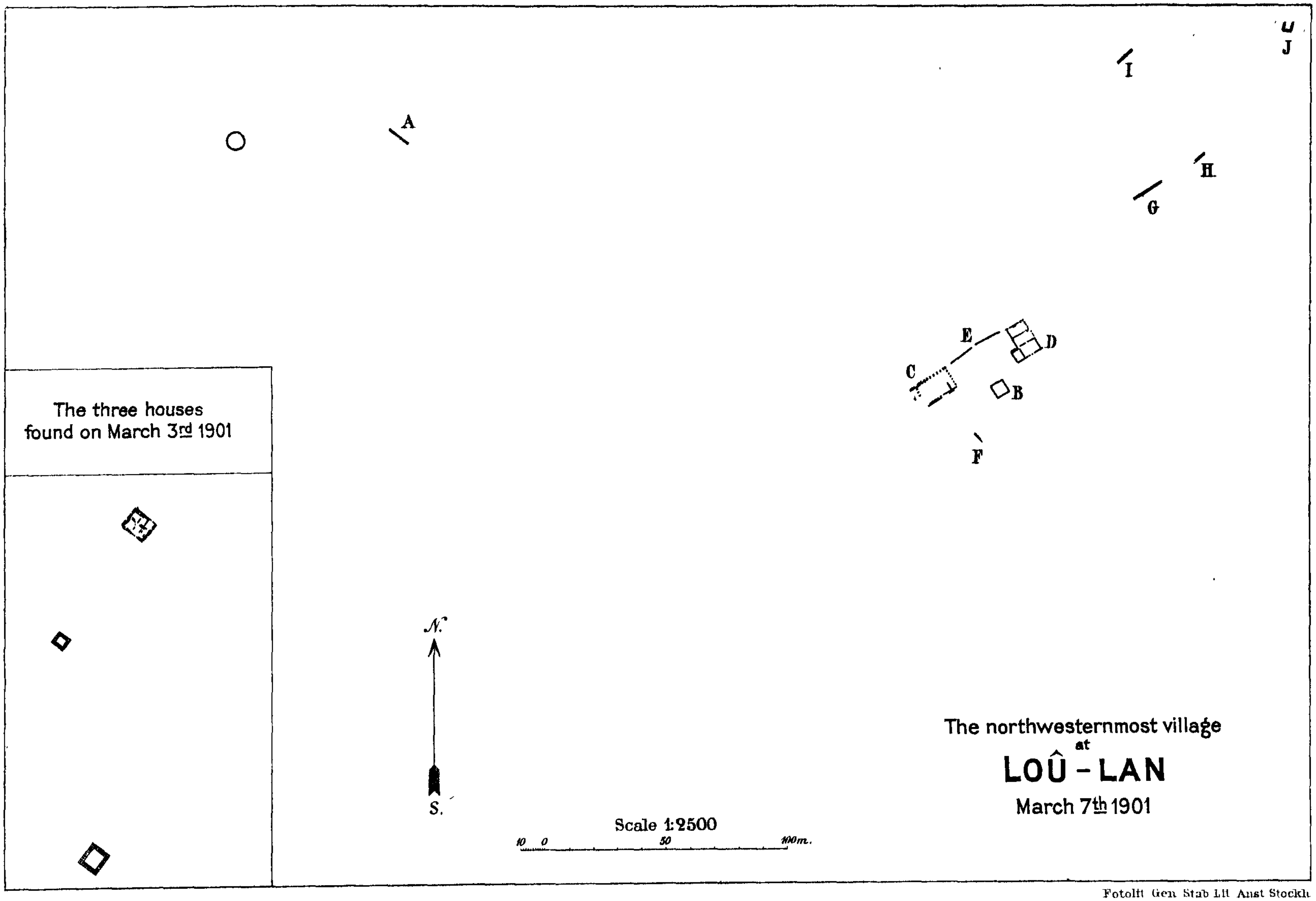
* Illustrations of all these wood-carvings will be found in Prof. A. Conrady's archæological part of this work.

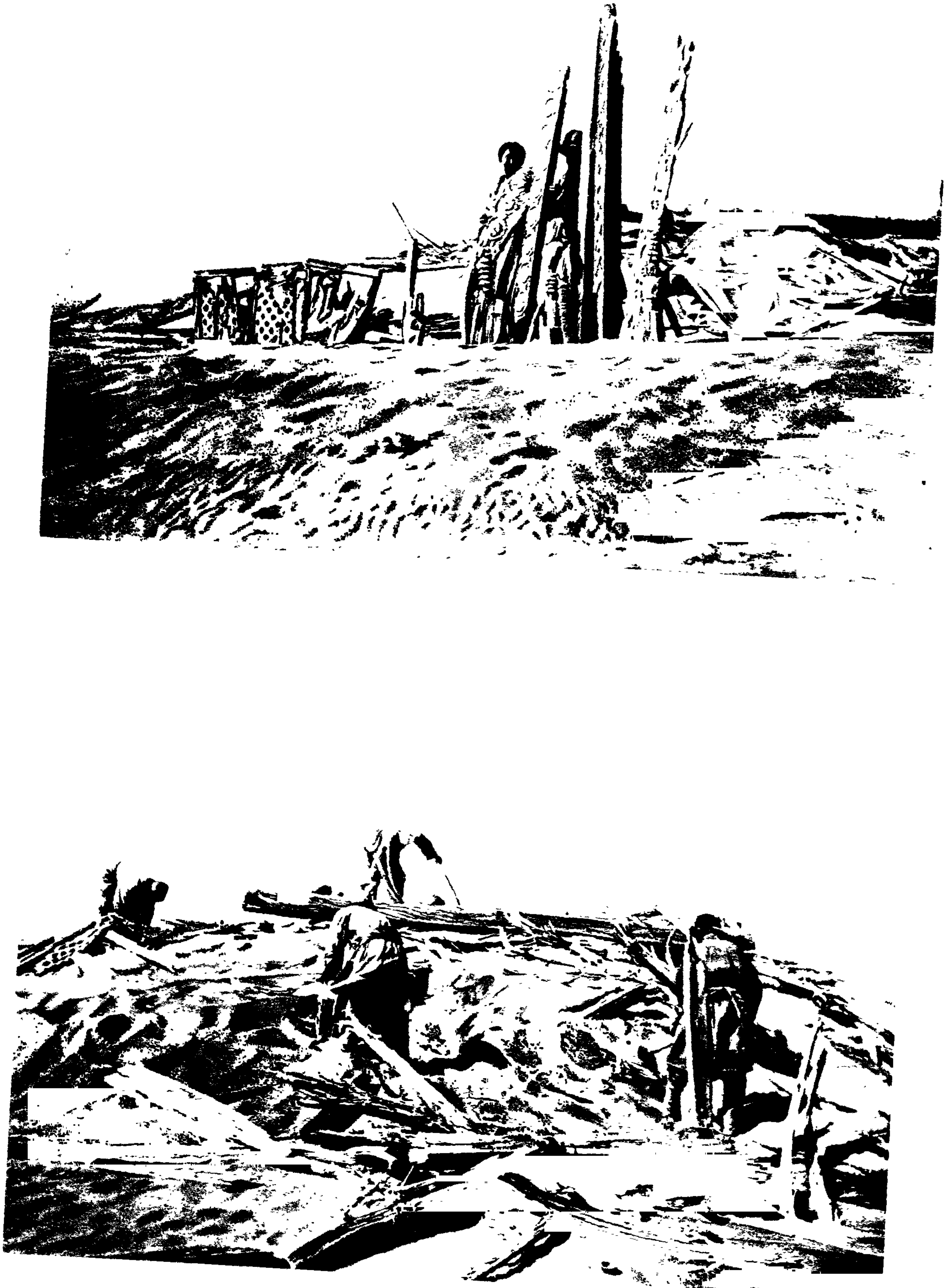


The three houses found on March 3rd 1901

The northwesternmost village at LOÛ-LAN March 7th 1901

Fotolit Gen Stab Lit Anst Stockh

Pl. 76.



Ljustr. A. B. Lagrelius & Westphal

EXCAVATING LITTLE "TEMPLE" IN MOST NORTH-WESTERLY VILLAGE OF LOU-LAN.

on; some Chinese copper coins; and — the most important of all — a tablet of wood, 4 × 6 cm., crowded with lettering, the nature of which I leave it to the specialists to explain.

The two wings of the building were devoid of ornamentation. The answer to the question, as to whether this little temple was thus tastefully and richly decorated on the inside or on the outside, must be that it was probably on the inside. The structure is not so big but that it is quite conceivable, that the whole of the interior may have been decorated in this manner. As I have stated, the carvings were also painted. In what way the various parts, the planks and squares, were fastened together cannot be determined, though the latter were evidently used to break the continuity of the former. The large plank shown on one of the plates in the archæological part and also on fig. 294 shows plainly that the pattern was not contained entirely upon it, but ran over on to the adjacent planks, which must consequently have touched it. Yet even with the help of all the fragments that survive, it would be too rash to attempt a reconstruction that would be likely to carry anything like conviction The ground-plan of the edifice may be inferred from the four massive foundation beams, with the holes cut in them for the vertical posts. It may be assumed that the doorway and door, or double doors, had the same appearance as those of the house M (village at Camp CLIX). But here again we have no sure means of deciding what the roof was like. The turned spiral also shown on the right of one of the plates in the archæological part may possibly afford some slight clue. Although we found several of these, we only brought away one as a specimen. They were probably used to decorate the roof ridge, or its horns. I observed roof terminals of this kind on every temple in Kum-bum, the architecture of which is greatly influenced by Chinese models; though the temple buildings at Hemi are constructed in the Tibetan style. With regard to the temple and the larger houses of Lôu-lan, we may be quite certain that Chinese models had a far greater influence upon their builders than they had at Kum-bum. If then the small spirals of different sizes (the largest is 57 cm. high) of which I have been speaking were employed in the manner indicated, the roof can hardly have presented any other form except that of the usual high-pitched Chinese ridge with gently upcurving horns at the ends.

This neighbourhood too, in the extreme west of the villages we discovered, was virtually free from drift-sand. It was only on the south-west side of the jardangs and mounds that an occasional small dune had accumulated. In the vicinity of the temple mollusc-shells were extraordinarily abundant, and very often they lay in heaps in the little hollows, having been swept together by the wind like withered leaves. In consequence of the uninterrupted wind-erosion an increasing number of mollusc-shells continue to be shaken out of the clay deposit which formerly settled on the bottom of the lake. We often used to see them sticking like white dots all over the sides of the jardangs; these were of course only half exposed, but as the corrasion continues they will gradually become loosened and fall out.

This concludes my brief description of what was to be seen on the site of our two visits, unfortunately too short, to the place. The ruins, consisting of four villages and a solitary tower, stretch along a line that runs from N. 60° W. to

S. 60° E. The two outside villages in east and west are the largest, and lie 14 km. apart. This general position proves that they stood in part beside a tolerably straight road, and in part on the shore of a lake. It may quite safely be assumed, that this road was connected with the old road of which I discovered distinct traces in 1896 while travelling between Korla and Jing-pen. The traces in question consisted principally of *potajs* or watch-towers. Two of these, standing between the Kontsche-darja and the Kuruk-tagh, are reproduced in figs. 34 and 35. These two clay towers have, as will be seen, a very different shape from the large tower at Lôu-lan. They are truncated pyramids, while the latter is a truncated cone, at all events in its upper part. Moreover they are hollow inside and once contained a stairway to the summit. The materials of all the towers alike is however the same, namely clay, built round a frame-work of posts and branches of trees. One of these quadrilateral towers was surrounded by a similar quadrilateral wall (fig. 35). In any case all these ancient remains belong to one and the same vigilantly guarded road along the southern foot of the Kuruk-tagh. If you were to proceed successively from each of the groups of ruins I discovered to the next, and were to endeavour to follow the probable course of this ancient highway, you would in all probability find several other old ruins. As for Lôu-lan, it was simply and solely by pure chance that I was led to visit the four villages. Why then should there not be others like them on both the east and the west! Between Jing-pen and Lôu-lan I travelled indeed for the most part in the bed of the Kuruk-darja, and there may have been ancient villages on its banks which we did not see. It is the configuration of the country that makes it so difficult to discover the ruins. It is quite possible to go past the ruins of a house at a distance of only twenty meters or so, and yet never be aware of their existence. Kosloff does not speak of any ruins along the *astin-jol* to Tung-chuan; but this cannot of course be regarded as a proof that none exist. For, in the first place, the road between Lôu-lan and the existing Tung-chuan is entirely unknown; and in the second place the eastern half of the road may have had quite a different position in the desert from what it has now. Future exploration in this region will beyond doubt result in yet further discoveries.

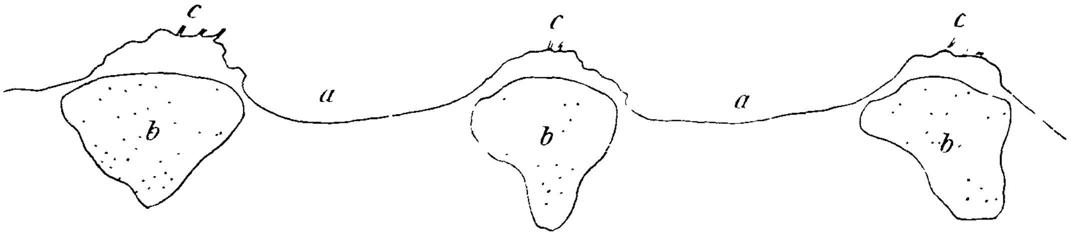


Fig. 296. a. = GULLIES STRETCHING NNE—SSW; b. = SAND ON THE LEE SIDE, OR SSW. c. = JARDANGS.

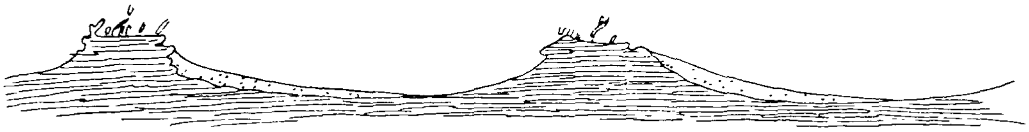


Fig. 297. VERTICAL SECTION OF THE SAME FROM NNE TO SSW.

# CHAPTER XLVI.

## TRANSCRIPTION OF GEOGRAPHICAL NAMES IN CENTRAL ASIA.

By Dr. K. B. WIKLUND.

Nobody who studies at all closely the geographical or historical literature of any part of the world can help feeling at times hampered and impeded by the great and unexpected difficulties put in his way by the names of the geographical and historical localities he is dealing with. This is not indeed so likely to be the case if his study is concerned with any of the older civilised countries, for in them the names of towns, lakes, mountains, and so forth have gradually acquired time-honoured, official forms, which naturally find their way into books. But when the investigator turns to the older literature of his subject, it is too often difficult for him to identify and recognise again the names he there meets with; he is bewildered by the strange forms they assume, and all too easily he is misled into giving them a false interpretation. And even when he confines his attention to modern literatures, and chances to discuss with a philologist some of the time-honoured topographical names, which are used by everybody, scholars or not, without the slightest suspicion, both in speech and writing, he may perhaps be told, no doubt to his great surprise, that the philologist looks very much askance at some of these well-known names, and pronounces them to be in some way or other corrupt. Sometimes indeed the criticisms of the scientific may be so convincing as to constrain the authorities to subject the local topographical nomenclature to an official revision, as happened, for instance, recently in Sweden.

Swedish place-names have been perverted in several different ways and by several different means. Frequently the belief has arisen that this or the other name is a distortion or curtailment of some well-known word, and the attempt has been made, by incompetent persons, to correct it and put the »right» word in its place. For instance, the town Simrishamn used always to be written Cimbrishamn, under the erroneous idea that it derived its name from the ancient Cimbri. Thus we have here an instance of »popular etymology». There is no branch of linguistics which has been so popular with the great public both in Sweden and elsewhere as the explanation of place-names, and within the limits of this science there is no department within which dilettanti, destitute of knowledge and ignorant of logic, so often and so eagerly give free rein to their fancy as in the interpretation of place-names — just that branch of the science of philology which the trained investigator regards as the most difficult, and as making the severest demands upon his knowledge.

A vast number of other place-names have been corrupted by faulty hearing or faulty spelling at the time the locality was surveyed, or as a consequence of deficient local knowledge on the part of the persons from whom the topographers have chanced to seek their information with regard to the various localities they have studied. Nor have the maps been subjected to the revision of a scientific philologist before being printed; and once they are printed, they have been regarded, consciously or unconsciously, as authoritative and unalterably correct.

These reflections, suggested by the history of place-names in Sweden, may without any very great change be applied to the study of the nomenclature of several other civilised countries. Whence we see, that place-names are corrupted by those who study them even when they have themselves from childhood spoken the language to which those names belong. How much more easily therefore, and how much more frequently, will the place-names be corrupted when the language to which they belong is not the mother tongue either of the observer who records them or of the scholar who edits them, and who have either a very slight knowledge, or none at all, of the language in question. In such circumstances it is evident, that mistakes are unavoidable, and indeed they may be expected to be fairly numerous, especially when the observer is not a trained philologist nor can possibly be so.

To ensure absolute and complete accuracy in the topographical nomenclature of any region, the names ought therefore to be recorded by a skilled philologist. Nor is it sufficient that he should have had a thorough grounding in the general study of philology; it is equally indispensable that he should know the dialect spoken in the region under investigation, no matter whether it is a dialect of his own mother-tongue or of some other language. To philologists this statement is self-evident. To non-philologists it may possibly appear too exacting. It will not be superfluous therefore if I illustrate the point from my own experience as a student of the Lapp dialects. Whenever I visit a fresh dialectal region, I find invariably that the observations I gather during the first few days regularly turn out to be more or less defective and inaccurate in respect of various minutiæ. The reason of this is, that for the first few days my ears are not yet accustomed to the new dialect. And this happens notwithstanding that I am familiar with investigations of this character, that I possess more than a theoretical acquaintance with phonetics, know the Lapp language, and do not possess a too insensitive ear. In the case of a less practised inquirer, the errors would not be confined to minutiæ alone, but they would extend to more important matters, a thing which may indeed also happen in the case of even a very well-trained observer. For it is no easy matter to hear correctly, perfectly simple though this may seem to the layman. In place of the more or less unfamiliar sounds that are pronounced by the person you are questioning, you unconsciously substitute sounds you are familiar with that most closely resemble them, and often a pretty considerable time elapses before the difference is perceived. Very frequently it turns out, when you come to sift and arrange the materials you have collected, that the difference is one of no consequence, and in fact immaterial; but on the other hand it often proves the means of suggesting a more or less valuable contribution to a correct conception of the historical development of the dialect or language in question.

Hence it is, I hope, perfectly clear, that the record of the place-names of any locality can only lay claim to be definitive and final when it is made by a trained philologist who possesses an accurate knowledge of the dialect spoken in that locality. Without that it is not possible to secure a perfectly reliable basis for further investigations into the history of human settlement in the same locality, because the place-names constitute an important element in such investigations; any more than you can in non-philological literature obtain any trustworthy foundation for the correct spelling of the local place-names. For, as a rule, the system of transcription which is employed in that literature is essentially different from the system which is best suited to the purposes of pure philology. The phonetic system of most languages is such that it can be reproduced only very imperfectly by means of the traditional Latin alphabet. Consequently for philological purposes we have to employ a more developed phonetic alphabet. Many alphabets of this kind have indeed been proposed, as well as actually used. Of these the now antiquated Standard Alphabet of Lepsius is perhaps that which is best known by name outside of the science of philology. Alphabets of this character, with their array of subtle distinctions and strange-looking letters, cannot however be employed in ordinary books. In these a far simpler system must be used, which nevertheless, if it is to be consistent, and so far as it goes accurate, must of necessity be based upon, and be controlled by, a scientific and exact knowledge of the pronunciation of the language under consideration.

My object in beginning with this lengthy introduction is to emphasise the fact, that a very long time is likely to elapse before we can hope to obtain fixed, and at the same time correct, forms for the millions of geographical names which figure on the surface of the earth. In many of the older seats of civilisation the place-names have not yet been examined — how much more therefore in the distant lands of Asia, of Africa, and of America! And before these millions of names can be investigated and analysed, thousands upon thousands of them will get established in incorrect forms, and so will come into frequent and general use, whereby the faulty forms acquire such a degree of authority that, when their correct form is at length demonstrated, it is far too late to attempt to introduce any change in the established usage. Accordingly we have by no means heard the last of such complaints as that to which Dr. B. Hassenstein has given utterance in *Petermanns Mitteilungen*, Ergänzungsband 28, pp. 382 ff. »Dass aber trotz aller Ortsverzeichnisse die Durchführung einer von allen möglichen Inkonsequenzen und Fehlern freie Nomenklatur ein Ding der Unmöglichkeit ist, solange wir Kartographen auf das bunte Gemisch von Materialien aller Nationen angewiesen und nicht in der Lage sind, selbst alle Sprachen *ex fundamento* zu studieren, wissen wir nur zu wohl.« And even on the appearance of Dr. Sven Hedin's great book the same complaint would be raised with regard to the Central Asian names, notwithstanding the well-known fact of Dr. Sven Hedin's great linguistic attainments being a sufficient guarantee for the belief, that his reproduction of the native names is far better than that of any of his predecessors in the same part of the world.

When Dr. Sven Hedin was beginning to print the first volume of this work, *Scientific Results of a Journey in Central Asia 1899—1902*, he, acting upon the advice of Dr. E. Dahlgren of Stockholm, applied to me to know if I could furnish him with a consistent system of orthography to be used in the spelling of the place-names of Central Asia. Thereupon I drew up briefly certain suggestions to that end, which had the good fortune to meet with Dr. Hedin's approval. In drafting my proposals, I started from the following fundamental principles:

*A system of spelling that is intended to be used in a non-philological work ought to be*

*I. Consistent;*

*II. So clear that it cannot possibly be misunderstood;*

*III. Represented exclusively by the ordinary letters of the Latin alphabet.*

A priori everybody would without hesitation agree to these fundamental principles; but when it comes to deducing conclusions from them, it may very readily happen that doubts arise. I feel it incumbent upon me therefore to set forth certain of these conclusions, and to discuss them more in detail in regard to the new points of view which the discussion itself may possibly bring to light.

## I. THE SYSTEM OUGHT TO BE CONSISTENT.

If a word contains the sound which in English is written *sh* in *sheep*, then it ought not in the same book to be written sometimes in that way and at other times in another way; but *one* uniform spelling of that particular sound ought to be decided upon and adhered to throughout, no matter whether the form chosen be the English *sh*, the German *sch*, the French *ch*, the Swedish *sj*, the Italian *sci*, the Bohemian *š*, the Polish *sz*, the Hungarian *s*, or any other form. My claim to consistency in this respect will be perfectly obvious to everybody. But the next point is not so easy, namely the agreement as to the particular sign which shall be employed to represent this sound, a sign that ought to be invariably used by all scientific writers in their scientific works. Let me put the statement in a more general form:

*Scientific workers of different nations ought to endeavour to employ as far as possible in their scientific works the same uniform international method of writing place-names.*

When an Italian, an English, or a Swedish traveller writes an account of his travels that is intended to be read by the broad masses of the people, then he may (and indeed sometimes ought to) use the method of spelling which his readers will readily understand, just as he ought to employ the system of measurement, the thermometrical scale, and so forth, that are usually employed in his own country; but if the same traveller publishes a scientific work dealing with his journey, then in the interests of international science, he ought no longer to consider national predilections. Everybody who has studied the geographical literature of different countries knows how great are the difficulties which lie in the way of a comparison and understanding of the different systems of orthography that are employed in different languages. These difficulties need not exist, and must be gradually eliminated.

The demand for orthographical uniformity in geographical literature stands on the same footing as the demand for a uniform system of measures, a uniform thermometrical scale, and so forth. The same national prejudices and the same difficulties which have hitherto prevented the introduction of the metric system and the Centigrade thermometric scale stand in the way of the introduction of a uniform orthographical system. It must be admitted, however, that even though the national scruples were overcome, there would still remain a number of difficulties in connection with this question of a uniform orthography, which it will be by no means easy to overcome. For not only can an orthographical system such as that which is desiderated not be established in a manner that is at once as mathematically clear, simple, and unassailable as a system of measures or a thermometrical scale, since different standards of clearness and accuracy in transcription are set up by different languages, and their requirements with regard to these desiderata are sometimes divergent; nor can these varying orthographical ideals be forced to submit to one rigid system without suffering material damage. Hence to seek to set up an *absolute* orthographical system is to aim at a chimæra.

The conclusions reached by the above considerations with regard to the representation of the *sch* sound may be developed into the following law: *The same sound ought in writing and in print always to be expressed in the same manner, by means of the same orthographical sign or group of signs.* In philological literature the following proposition is also generally observed: The same orthographical sign ought always to indicate the same sound. Accordingly the sign *š*, which is met with in a number of phonetic alphabets, ought to indicate one sound only, namely that which the Englishman represents by *sh* as in *sheep*, the German by *sch* as in *schön*, the Frenchman by *ch* as in *chanter*, and so on, that is to say, the »voiceless *sch* sound». At the same time the same sign ought not to be employed to indicate the »voiced *sch* sound», which the Englishman writes *si* as in *occasion* and the Frenchman *j* as in *jouer;* but for this a special sign ought to be employed, for instance *ž*. In a similar manner the sign *s* ought to be used solely for the »voiceless *s* sound», such as we hear it in the English *set*, the German *ist*, the French *salon;* whereas *z* is most commonly employed to distinguish the »voiced *s* sound» that we hear in the English *easy*, the German *gewesen*, the French *poser*. The phonetic alphabets therefore that distinguish between a very great number of different sounds exhibit a remarkable complexity of strange signs, so that a text accurately written according to strict phonetic rule is wholly unintelligible to anybody except the trained philologist.

Hence it is clear, that in laying down an orthographical system for use in geographical literature the proposition quoted above must not be inverted; but instead of that, several of the sounds which philologists distinguish must be included under the same sign, for instance all the varieties of the *a* sound under the sign *a* and of the *l* sound under the sign *l*. The only question is how far it is expedient or necessary to proceed in this method of simplification, or to speak in the language of philology, how broad the transcription may and ought to be. For my own part, I should, for example, welcome a distinction, in the writing of Turkish place-names, between the voiceless and the voiced *s*, that is to say between *s* and *z*, because the Turkish language does distinguish between these two sounds, so that some words are differentiated only by the quality of their *s* sound; for example, the East Turkish *kasmak* = »der Grund, Boden des Kessels oder der in demselben angebrannte Teil der Speise», and *kazmak* = »graben, herumirren, herumstreifen». But in this present work I was not able to carry out this requisite distinction, because Dr. Hedin when originally noting down his observations on the spot did not discriminate between the two sounds. In some cases I could indeed, with the help of the dictionaries, have corrected his orthography by writing, for example *muz* = *ice*, in place of his *mus*, and *kizil* = *red*, in place of *kisil*. But too often the dictionaries would have proved of no assistance; for this reason therefore I had to abandon the idea of discriminating between the two sounds.

Now similar questions might arise in other languages, so that it is impossible to decide, off-hand and once for all, how far the process of simplification ought to be carried in the transcription of the geographical nomenclature.

## II. THE TRANSCRIPTION OUGHT TO BE SO CLEAR THAT IT CANNOT POSSIBLY BE MISUNDERSTOOD.

If I write the East Turkish word for »stone» in the French way as *tach*, then the Englishman would pronounce it as *tatsch* and the German as *tach*, with the guttural sound, whereas the final sound of the word is in reality the same as the English *sh* in *sheep*. Consequently the spelling *tach* may easily be misunderstood by the non-philological reader, and therefore is not a convenient form to adopt.

If, again, I write the East Turkish word for »great», which begins with the same sound as *ch* in the English *child*, in the English way as *chong*, then the Frenchman will pronounce it as *schong* and the German with the guttural. Consequently the spelling *chong* may easily be misunderstood, and is therefore not a convenient form to adopt.

The first sound in the last mentioned word is compounded of two others, a *t* sound and a *sch* sound. If now I represent the *sch* sound by *sh*, and consequently write *tash*; then, to be consistent, I ought to write the latter word *tshong*. But this word may easily enough be interpreted as *ts* + *hong*, that is to say as an »aspirated» *ts* + *ong*. Aspirated *ts* sounds of this kind do occur in the Indian languages, in Tibetan, in Chinese, and so forth, and must not, either in the scientific or in the broader transcription, be confounded with the ordinary *ts*. But even though in the broader transcription one were to embrace *ts* and *tsh* under one common sign *ts*, or for the aspirated *ts* were to choose some other sign, as for example *tsʻ*, the sign *tsh* in the sense of *tsch* (the English *ch*) would nevertheless be strange and unfamiliar even to the ear of an Englishman, and one would always be tempted to pronounce *tsh* as an aspirated *ts*, and not as *tsch*. Consequently the use of *tsh* may easily be misunderstood and therefore is not a convenient form to adopt.

We have already seen that the form *ch* is not suitable to express the *sch* sound, and the consequence is that we cannot use *tch* either to indicate the *tsch* sound, which is a compound of *t* + *sch*.

The Swedish way of spelling the words would be *tasj* and *tjong*; but here the *sj* and *tj* might readily enough be taken for palatalized *s* and *t*. A Hungarian would write the two words *tas* and *csong*, while a Pole would spell them *tasz* and *czong;* but it hardly needs to be said that these forms are not to be recommended. The Bohemian *taš* and *čong* would perhaps be the forms that the philologist would most prefer, because in philological works the sounds in question very often are expressed in precisely this way; but for those readers who are not philologists these signs would be incomprehensible, to say nothing of their being in conflict with the third principle laid down below.

Hence there remain, so far as I am able to see, only the two signs *sch* and *tsch*, which are not very likely to be misunderstood by any civilised nation. The fact that these signs happen to agree with the German methods of orthography is really a matter devoid of importance, seeing that we have agreed to disregard all national susceptibilities. Moreover both these signs are well known already to everybody from a host of maps and books of travel.

These two sounds, *sch* and *tsch*, are voiceless sounds. The voiced sounds which correspond to them are indicated by the English sign *si* in *occasion* and by *j* in *joy* respectively, in French (the former sound only) by *j* in *jouer*, in Italian (the latter sound only) by *gi*, in Hungarian by *zs* and *dzs*, in Polish by ż and *dż*, in Bohemian by ž and *dž*, and in philological works often by ž and ǰ. Thus there exist various methods of writing the sounds in question, and none of them can be recommended for use in geographical literature, either because they are not clear and unambiguous or because they are in conflict with the third principle discussed below. If we were to employ the English *j*, it would be read by a Frenchman as ž, and by most other nationalities as *j* (= English *y* in *you*). In Dr. Hedin's work there does not arise, it is true, any special difficulty in connection with these sounds, because when noting down his observations on the spot, he did not discriminate between ž and š (any more than he did between *z* and *s*); consequently there was no need for me to devise any suitable combination of signs to reproduce *z*, and indeed the problem appears to me to be almost insoluble. I had therefore merely to find a convenient sign to represent *d* + ž, which Dr. Hedin wrote *dj* in analogy with *tj* = *t* + *š*. Most people would however interpret this *dj* as *d* + *j*, that is to say, as a palatalized *d*, and for this reason I decided that it would not be clear, and consequently would be misleading. I chose therefore as being the least ambiguous the combination of letters *dsch*, which is frequently met with in German books. This shows not only that one has not to do with a palatalized *d*, but also that the spirant, when it immediately precedes a consonant, is not a voiceless *t*, but a voiced *d*. When pronouncing *dsch* the immediately following *sch* generally tends unconsciously to become voiced, and the result is the *dž* that was desired.

In addition to the spirants already discussed several languages have a number of others, which cannot without great inconvenience be replaced by any of the five spirants that occur in the traditional Latin alphabet, *f*, *h*, *j*, *s*, *v*, and yet they must be expressed even in geographical literature. One such sound is the voiceless interdental spirant, the English *th* in *thick*. The sign *th* has been used almost traditionally as the sign of the spirant in question, and it is employed without hesitation in, for example, Icelandic names, where it is put in place of the Icelandic þ, which is a violation of the third principle discussed below. For the same good reason *dh* is nearly always employed to represent the corresponding voiced spirant = Icel. ð, Engl. *th* in *there*.

Phonetically the spirant *th* is related to the »explosive» *t* in precisely the same manner as the spirant *dh* is related to the explosive *d*. Hence we obtain the following simple rule of transcription: If it becomes necessary to invent a new sign for a spirant, put an *h* after the sign for the corresponding (»homoorgan») explosive. Agreeably to this law, the voiceless guttural spirant is indicated by *kh*, because the corresponding explosive is *k*, and the voiced guttural spirant is represented by *gh*, because the corresponding explosive is *g*. In this present work however I have not quite seen my way to employ the sign *kh*, but have used *ch* instead of it. But in reality this is not at bottom such a great departure from the consistency aimed at as at the first sight it might appear to be. For the letter *c* is an old-established sign for the *k* sound; indeed the latter is in the Romanic languages constantly indicated at the present day by the sign *c*. Compare also the English *come*, *can*, and so forth. In accordance with old philological tradition the sign *ch*, and not *kh*, should be used as the sign to indicate the voiceless guttural spirant provided one does not make use of the sign *x*, a sign which is hardly suitable for geographical orthography, because in the alphabets of the usual civilized nations this sign is equivalent to *ks*. The Greek letter *χ* is also used in this signification, but we are debarred from using it in the present case by principle III (below). The use of the sign *ch* is of course attended with this danger, that in English it is equivalent to *tsch* and in French to *sch*, and it is only in German that it is a guttural spirant. All the same I have felt constrained to employ it in place of *kh*, which occurs in no language with the same significance, because by so doing, we are at liberty to use the latter sign to indicate another sound, of which I will speak presently.

According to the rule laid down above, the voiced guttural spirant (= German *g* in *Wagen*) is indicated by *gh*, a sign which has indeed been generally employed for that purpose not only in philological works but also in others.

As additional terms in the equation *t : th* = *d : dh* = *k, c : kh, ch* = *g : gh* we might also have *p : ph* and *b : bh*. The voiceless labial spirant is however usually designated in the Latin alphabet by *f* and its voiced counterpart by *v*. In this way *ph* and *bh*, which otherwise are demanded by the consistency aimed at above, are left free to be used to represent other sounds, and what those sounds are we discover when we turn to the languages of India. In these there occur entire series of »aspirated explosives», which are differentiated from the usual explosives *p*, *b*, *t*, *d*, *k*, *g*, by being immediately followed by an aspirate, a sort of *h* sound. It has long been the established practice when transcribing into the Latin alphabet to represent these sounds with the signs *ph*, *bh*, *th*, *dh*, *kh*, *gh*. Hosts of examples may be found in every map of India. A number of similar *ph*, *kh* etc. are found in the Indo-Chinese peninsula and in several books about China.

If, then, a place-name is encountered outside of classical literature containing the signs *ph* or *bh*, we may generally be quite sure that it is intended to represent an aspirated *p* or *b*, not the corresponding spirants *f* and *v*. Again, if we come across a *th* or *dh*, we cannot without closer examination decide whether it is intended to represent an aspirated *t* or *d* or a spirant *þ* or *ð*. If the name is an Icelandic or an English name, then it is a spirant that is meant; but if it belongs to one of the tongues of India, then it is an aspirated explosive which is intended. We could of course easily decide to get over this difficulty by indicating an aspirate after an explosive by the sign ‘ (*k*‘, *p*‘, *t*‘ etc.), this sign being already used in various books about China. The signs *kh*, *dh*, *gh*, etc. have however in Indian names acquired such authority, and have become so well established in this particular meaning, that it would be quite impossible to introduce a change in this respect. Hence it is, it seems to me, necessary to let these signs with *h* represent both the aspirated explosives and the spirants according to the linguistic province with which we are dealing. Thus the signs *ph* and *bh* will generally represent explosives, and it might be advantageous to let *kh* stand for the explosive and *ch* for the spirant.

In addition to the usual *k* there occurs also in Turkish, and in Semitic and other languages, a deeper or velar *k*, which is often written *q* in both philological and geographical works. This sound occurs also in the Turkish dialects of Central Asia, and for philological reasons it would be interesting to have a special sign to indicate it, and write, for example, *qizil* = red, an orthography which cannot very well be either ambiguous or misleading, though perhaps the distinction may appear to many to be too refined. But as Dr. Hedin in making his observations did not discriminate between *q* and *k*, I was of course unable to carry out the differentiation.

In the traditional Latin alphabet *j* represents the same sound as the English letter *y* in *young*, a sound represented in most languages by *j*. It is obvious, that the sign *j* must be retained with its original signification, all the more as the sign *y* is required to indicate a certain vowel (see below).

In the Latin alphabet as in most modern languages *v* is used to represent the sound which we hear in the initial letter of the English *visit*. This traditional usage of the sign *v* could not therefore, obviously, be departed from, or yield place, for instance, to *w*, as Dr. B. Hassenstein desired in *Petermanns Mitteilungen*, Ergänzhft. 28, p. 383. It is indeed true that in original German words the *v* sound is indicated by *w*, whereas *v* is pronounced *f*; but every educated German knows also that his mother-tongue contains a number of loan-words in which the *v* sound is represented by the sign *v* (e. g. *V*okal, No*v*elle etc). Consequently this letter *v*, when it occurs in place-names, cannot be ambiguous even to a German. If the sign *w* is to be employed, it ought rather to be reserved to express the generally known value of the English *w* in *water*.

For the *ng* sound, I have employed the German, English, Scandinavian, etc. sign *ng* (= English *sing*, German *singen*).

With regard to the vowels there is little to be said. The signs *a*, *e*, *i*, *o*, *u* ought without any discussion to be allowed to retain their traditional values = French *a*, *e*, *i*, *o*, *ou*, German *a*, *e*, *i* *o*, *u*. In many districts there occurs an opener *e* sound which requires to be separately indicated, and for this purpose the generally known sign *ä* is the most convenient. Similarly the sound value of the sign *ö* is everywhere recognised, even though there are several languages in which it does not occur. The sign *ü* is required to express the sound which the French indicate by *u* and the Germans and Hungarians by *ü*, while the Scandinavians write it *y*. In the more popular account of his journeys which preceded this present work Dr. Hedin indicated this sound in the Swedish way with a *y*; but as outside of Scandinavia and Finland (and in certain loan-words in German) this value of the sign is not known, I thought it better to substitute for it the more generally known and more widely used *ü*. In this way the sign *y* becomes free for use as the sign to represent the back *i* sound, which occurs in many Turkish and Slav languages (Polish *y*), and it is in this way that the sound has generally been represented.

## III. THE USUAL LATIN LETTERS ONLY MUST BE EMPLOYED.

It may seem superfluous to adduce special proofs of the necessity for this proposition. In an alphabet designed for the use of philologists, all possible signs and letters might of course be used, because it is part of the philologists' ordinary training to understand phonetics and phonetic signs; but we cannot ask people who are not specialists in philology to have a knowledge of such letters as *š*, *č*, *ǯ*, *δ*, *ṅ*, *ñ*, *ŋ*, and several others. The only letters outside the common usage which I felt that I might permit myself to employ in my orthographic system are *ä*, *ö*, *ü*, signs with which every well-educated person may be assumed to be familiar.

Concisely, the orthographical system which has been employed in this work in the transcription of the geographical names of Central Asia is as follows:

### Vowels

*a*, *ä*, *e*, *i*, *o*, *ö*, *u*, *ü*.

### Consonants

Explosives *b*, *d*, *g*, *k*, *p*, *t*.
Spirants *f*, *ch* (as in German *nach*), *gh* (German *Wagen*), *h*, *j* (English *you*), *s*, *sch* (English *sheep*), [*tsch* (Eng. *child*), *dsch* (Eng. *joy*)], *v*.
Liquids and nasals *l*, *m*, *n*, *ng*, *r*.

I trust that in this system I have succeeded in satisfying the requirements both of theoretical correctness and practical utility, that I have successfully kept in view the limitations which external circumstances impose upon the successful carrying out of the scheme, and that I have worked out an orthographical system which rises superior to national predilections.

When Dr. Hedin consulted me with regard to the spelling of the Central Asian place-names, I submitted to him a rough sketch of the orthographical system which I have endeavoured to explain and justify in greater detail in the preceding paragraphs; but at the same time I told him that I could not venture to be answerable for the practical application of the system to the existing material, not considering myself competent for the task on the ground that I am no specialist in Turkish, Mongolian, Chinese, etc. Yet at Dr. Hedin's repeated request I finally felt impelled to take the work in hand, more particularly as much valuable time would inevitably have been lost had he been compelled to appeal to a philologist outside of Sweden to correct both text and maps in the minute way that was obviously required in the application of such a system as that which I had drawn up.

The sources which I had at my command for the study of the East Turkish dialects were: H. Vámbéry, *Ćagataische Sprachstudien* (Leipzig, 1867); Sejχ Sulejman Efendi, *Čagataj-Osmanisches Wörterbuch* bearbeitet von Ignaz Kúnos (Budapest, 1902); R. B. Shaw, *A Grammar of the Language of Eastern Turkistan*, in *Journal of the Asiatic Society of Bengal*, Part I, vol. XLVI (Calcutta, 1877) and the same author's *A sketch of the Turki Language as Spoken in Eastern Turkistan* (*Kàshghar and Yarkand*), Part II: Vocabulary, *Ibid.*, vol. XLVII (Calcutta, 1880). Unfortunately I was unable to make the use that I expected of Shaw's work owing to considerable ambiguity in the sound-values that he assigns to the vowels. As to the relation between Radloff and Shaw in the matter of the passages which the former quotes in his great dictionary from the work of the latter I do not venture to express any opinion. For the Mongol dialects used in the Mongol regions visited by Dr. Hedin there do not exist any sources whatever; compare, for instance, what G. J. Ramstedt says about the Mongol dictionaries in *Journal de la Société Finno-Ougrienne*, XXI, 2, (Helsingfors, 1903).

In revising the geographical names which Dr. Hedin had collected it was open to me to proceed in either of two ways: *either* I might apply the system as above defined to the material just as it stood, without making any alterations in the forms of the words; *or*, when carrying out the transcription, I might at the same time reduce or »normalize« the word-forms into conformity with the written forms of East Turkish. Upon comparing the material which Dr. Hedin had printed in *Peterm. Mitteil.*, Ergänzhft 28, with the written language, I found that the differences were not important, and accordingly I felt justified in adopting the second of the two methods just indicated, for by this means the geographical nomenclature of these regions would gain immensely both in clearness and explicitness.

But owing to the plan of publication I was unfortunately not able to study the whole of the material at once, but had to revise the maps one after the other as they were successively finished in MS. by the cartographers, and it was only exceptionally that I had any opportunity subsequently of effecting such changes as for one reason or another seemed to be advisable, or of correcting any errors which I had made myself. As it happened, the first map of the atlas presented no very great difficulties, though even here there were many names that I failed to trace in the rather scanty lexicographical material that I had at my command; consequently these I was unable to normalize into agreement with the literary East Turkish language.

The normalizing of the place-names the meaning of which was clear consisted exclusively in the adoption of the above described alphabet, as also in the simplification of a number of consonants which in Dr. Hedins note-books and in his list of names in *Peterm. Mitteil.* were written double. This duplication of the consonant occurred partly at the end of the first syllable before another consonant (*e.*

*g. jiggde, tjappgan*, etc.), partly between the first and second vowels of the word (*e. g. Kurruk, Tikkenlik*, etc.). In my sources I failed to find practically any traces whatever of long consonants, except in the case of words like *tallik*, where *-lik* is a derivative suffix, added to a root ending with an *l* sound. Consequently I was driven to conclude, that the duplication of the consonant, which occurred very frequently indeed, must, at any rate for the greater part, be due to faulty apprehension. This was a case too in which a Swede would be more particularly liable to err, owing to the fact that in his native language a consonant at the end of a syllable, following a short stressed vowel, is always long, while Swedish can show us no instance of short, stressed vowel + *short* consonant + vowel, this being replaced by the combination short vowel + *long* consonant + vowel. At the same time it is true that in Turkish words the accent falls upon the *last* syllable; but according to Radloff, *Phonetik der nördlichen Türksprachen*, § 136, the first syllable of the word has also a secondary accent, and, as I suppose, it was this which misled Dr. Hedin's Swedish ear. However that may be, I believed I had good reason to simplify the first of two succeeding consonants as well as the intervocalic consonant whenever I was able to get confirmation of the form of the word in the literary language. Nevertheless, as I discovered during the progress of the work, I had sometimes been needlessly afraid of simplifying the intervocalic consonant; but it was then, as I have already observed, too late to make any alteration, and it was only exceptionally that in the text which was printed later I was able to employ a slightly modified form of the name which appeared on the map; it would of course have been exceedingly inappropriate to have employed different name-forms in the text and in the map. The thought which dictated my scruples with regard to the simplification of double consonants was this: it might be just possible that in this or the other instance the pronounciation might preserve a long consonant of great historical interest, which I had no right to obscure by a simplification of spelling. Certain duplications which I noticed in Shaw confirmed my scruples with regard to this, and when in November 1904 a phonetically written Kaschgar text was for the first time printed, namely in the journal *Keleti Szemle* (Budapest), my surmise was converted into certainty. The only way to obtain complete certainty on such points as this is to make investigations in the locality where the dialect is actually spoken; sitting at my study table I have no means of determining which are the words in which an intervocalic consonant really ought to be written long, any more than a physicist can without cause alter a single figure in a result which he has reached by a process of rigid investigation or experiment.

Another of the principles which I endeavoured to carry through was, instead of using *g* in both the low-vowel and high-vowel words, as Dr. Hedin had done, to reserve *g* for the high vowel words only, and to employ *gh* for the low vowel words, following in this respect the spoken language. In the great majority of cases it was quite easy to carry through this principle, for it was evident on the face of the word itself to which of these two categories it belonged. Sometimes however very considerable doubt arose, owing to the fact that in the same word there appeared to be both a (at all events *ex oculis*) low and a high vowel, as for example in *Ugen-darja*, »also pronounced *Ögen-darja*». Had any other but a Swede written down this word, one could feel greater certainty that the *u* really was a *u*, and consequently a low vowel; but the Swedish *u* is a high vowel, which when it is long approximates to *ü*, and when it is short resembles an *ö*. If now the *u* in *Ugen-darja* is to be read as a high vowel the *g* would be the right sign for the sound of the letter that immediately succeeds it, otherwise *gh*. Clearly the simplest way would have been not to discriminate at all between *gh* and *g*; in that way the interpretation of the sounds would have been clearer, though at the same time with a resulting loss in scientific precision.

But it was more difficult to distinguish between the closed *e* and the open *ä*. Dr. Hedin had, it is true, made use of both these signs, but being a native of Stockholm he does not in his pronounciation of Swedish make any difference between these two sounds, though the natives of most other parts of Sweden keep them scrupulously distinct. Hence I could not be perfectly sure that he had in every case recorded the right sound, that is if the dialect does possess both *e* and *ä*. And upon this point I was doubtful. Vámbéry seems, it is true, (p. 13) to assume two sounds; but in Kúnos I find only *e* and in Radloff only *ä*. I endeavoured therefore to follow the latter as being the greater authority, and consequently put *ä* in a great number of words, in fact in as many as was possible; but at length the excessive number of these *ä*'s caused me to be doubtful, and on the whole I now think it would have been better to have left Dr. Hedin's orthography as it stood. It was then however too late.

Whilst the work of revising the earliest maps was in progress, the dialect appeared, as far as could be seen, to be in essential agreement with the East Turkish literary language, which conclusion I had arrived at when studying the list of names in *Peterm. Mitteil.*, Ergänzhft 28. On Sheets 9, 10, and 11 of the Atlas there occurred however a few names, which pointed to the existence of quite a different dialect, varying in essential particulars from the one I was dealing with — on Sheet 9 *Muhamed Kulluning-uji*, to the *Kullu* of which the corresponding literary form is *Kuli* = »his servant», a form which occurs also in Shaw; Sheet 10 *Ait-öttögön*, the final syllable in which ought to be *-gen* in the literary language; Sheet 11 *Momuni-ottogho*, the last member of which would be written *otaghi* in the literary language. This feature, the so-called »labial affinity in vocalic harmony», again made its appearance at a later stage in a vast number of names from the Lop country, and pointed to the so-called Eastern dialects (Radloff) where corresponding phenomena exist in the Teleut dialect and in the Altai dialect. In these cases it would be particularly inappropriate to normalize to the East Turkish literary language, because by so doing one would obliterate traces of national elements which have no immediate connection with the Kaschgar Turks, but on the contrary are possibly derived from the ancient Uigurs. For this reason I allowed these peculiar forms to stand unaltered.

Having reached this stage of the work, I was unfortunately prostrated with illness and for a considerable time totally incapable of work. In consequence of this Dr. Hedin had to continue unaided the revision of the maps and text and the application of the principles I had laid down. It was only when vol. II began to be printed that I was able to resume work. In consequence of this unfortunate break it is almost inevitable that numerous irregularities should have crept in, which neither I nor Dr. Hedin could prevent. Add to this, that, as I have already observed, I had no opportunity of studying the whole of the material collectively and all together, whereby I should have been able to lay a firmer foundation for the application of the system of transcription adopted, and it will readily be understood that it has not always been possible to carry out the simplification of the intervocalic consonants and the discrimination between *e* and *ä* in a perfectly satisfactory manner. To repair these defects in the Index would serve no purpose, especially as to do the thing properly a systematic study of the spoken language in the country where it is spoken is indispensably necessary. A thorough examination of these Turkish dialects, made by a specialist in Turkish, *trained in the methods of the modern philological school and familiar with dialectal investigation*, would pretty certainly yield valuable information also as to the successive waves of Mongols, Irans, and other races which have swept across those regions, and contribute materially to the solution of the problem as to the primitive home of the Turkish peoples. And it is with the expression of the hope, that this investigation may speedily be taken in hand, that the present writer concludes his labours upon the geographical nomenclature of Central Asia, a task which he only undertook under the pressure of circumstances.

# GEOGRAPHICAL NAMES.

## List of Abbreviations.

Al tr. = Alluvial tract.
Ar. = Arik (Canal).
Ba. = Bajir.
Bay = Bay.
Bd = Bed.
Bif. = Bifurcation.
Bnd = Bend.
Bol. = Boldschemal.
Br. = Bridge.
Brl. pl. = Burial-place
Bsn. = Basin.
Ca. = Canal.
Chl. = Channel
Cly. = Colony.
Con. = Confluence.
Cp. = Cape.
Crt. = Cataract.
Csai. = Caravanserai.
Ctry = Country.
Dist. = District.
Des. ho. = Deserted homestead.
Desic la = Desiccated lake.
Des. sa. = Deserted satma.
Des. st = Deserted station.
Des. vil. = Deserted village.
Dm = Dam.
Dn. = Dune.
Dpr = Depression.
Dst. = Desert.
Fd. = Ford.
Fld. = Field
Fo. tr. = Forest tract
Fsh st. = Fishing station.
Fst. = Forest.
Ft. = Fort.
Fts = Fortress.
Gd mi. = Goldmine.
Gf. = Golf.
Gn. = Glen.
Grg = Gorge.
Gt. = Gate.
Hl. = Hill.
Ho = Homestead
Hs = House.
Ht. = Hut
Id. = Island.
Inn = Inn.
Inh tr. = Inhabited tract.
Kdm. = Kingdom.
La. = Lake.
Ld. mi. = Lead-mines.
Lg = Lagoon.
Lp. = Loop.
Ltl bd. = Lateral bed
Ma. = Masar.
Mi. = Mines.
Ml. = Mill.
Mt. = Mountain.
Mts. = Mountains.
Mt ch. = Mountain chain.
Mt ra. = Mountain range.
Msh = Marsh.
Mth = Mouth.
Os. = Oasis
Pa gr = Pasture ground.
Pge = Pasturage.
Pk. = Peak.
Pl. = Place.
Pns. = Peninsula.
Po. = Pool.
Ppr gr. = Poplar grove.
Prm = Promontory.
Prov = Province.
Ps. = Pass.
Rd = Road.
Rd st = Road-station.
Rg. = Region.
Rge = Ridge.
Riv. = River.
Riv. a = River-arm.
Riv. bd = River-bed.
Riv. br = River-branch.
Riv. lo. = River-loop.
Rit. = Rivulet.
Ru. = Ruin.
Rvn = Ravine.
Sa. = Satma.
Sd. = Sand.
Sd. dn. = Sand-dune.
Sd. hl = Sand-hill.
Sh. tr. = Shore-tract.
Slt. bd. = Salt-bed.
Smt. = Settlement.
Sou. = Sound.
Sp. = Spring.
St. = Station.
St. hs. = Station-house.
Stm. = Stream.
Stp = Steppe.
Str. rg. = Strand region.
Tms. = Tamarisks.
Trb. = Tribe.
Tr. = Tract.
Tr. r. = Trade-route.
Trt. = Torrent.
Tn. = Town.
Vil. = Village.
Vl. = Valley.
Wtch. hs. = Watch-house.
Wl. = Well.

Abbasi-goturmesa. Str. rg. Abbas' Place for Carrying over Canoes. I: 118.
Abbas kirgen-kol. La. The Lake where A. went down. II: 513.
Abbas-kotormesu. Fo. tr. A's Place for carrying over Canoes. I: 149.
Abdal, Des. vil. A man's name; also a mendicant. I: 14, 78, 224, 388, 438 ff., 503, 509; II: 111, 113, 129 ff., 152 ff., 173 ff., 190, 205, 214, 216, 272, 275, 284, 471 ff., 486, 493, 503, 544 ff., 551, 601.
Abdal. Lakes of Abdal. II: 146, 152, 156, 208, 212, 216, 218, 333.
Abdal. Rg. II: 265.
Abdal-köli. La. II: 214.
Abdal-tschapghan. Ar. A's Canal. I: 427; II: 505.
Abdul Bakining-kona-koligi. Old La. A. Baki's Old Lake. II: 505.
Abdul Baki-uji. Des. vil. A. B's House. I: 188.
Abdu Semeti-modschughu. Prm. A. S's Cape. I: 251, 282.
Abdu Semet-kakmasi. Bay. A. S's Bay. I: 281, 282.
Achun-ilesi. Str. rg. The Gentleman's Road Mark. I: 217.

Adoke-kok-alasi. Riv. A's River Branch. I: 175, 185, 189; II: 513, 559.

Adok-ottogho. Pl. A's Dwelling-Place. I: 175.

Adok-uji. Ho. A's House. I: 183.

Ager-asti. Str. rg. The Suspended Saddle. I: 185.

Ager Kullune-köli. La. A. Kullu's Lake. I: 181.

Agertschi-Värghan-toj-bolghan-kok-alası. Ca. The River Arm, where A. V. celebrated his Wedding. I: 505.

Agha-bulak. Sp. The Gentleman's Spring. II: 85.

Aghesi-köl. La. The Lake of A. I: 230, 298, 306.

Aghir-bulak. Sp. The Heavy Spring; because the spring forms a waterfall. II: 37.

Aghis. Str. rg. The Mouth. I: 433, 435; II: 6.

Aghis-köl. La. The Lake of the Mouth. I: 190, 288, 294 ff., 469; II: 510.

Agir-asti. Str. rg. The Suspended Saddle. I: 403.

Agis-kum. Sd. High Sand. I: 55; II: 532.

Ahmed-kuduk. Wl. A's Well. II: 217.

Ahmedne-modschughu. Cp. Ahmed's Cape. I: 281.

Ahmetning-boltasi. Dry lake-basin. Ahmet's Sound. II: 508.

Aidin. St. II: 454.

Ait-öttögon. La. Where the Feast-time was Spent. I: 146; II: 556, 590.

Ajagh-aghis. Mth. The Lower Mouth. I: 399, 401.

Ajagh-arghan. Con. Lower Arghan. I: 191 ff., 416; II: 333, 339, 345, 592, 593.

Ajagh-karaunelik. Bol. The Lower Black Goose Place. I: 211.

Ajagh-kol. La. The Lower Lake. II: 141, 144 ff., 595.

Ajagh-kotormadake-koschlusch. Con. The Confluence of the Lower Passage. II: 510.

Ajagh-kum-kul. La. The Lower Sand Lake. II: 279.

Ajar-nor. La. II: 381.

Ajdin-köl. La. The Crescent-shaped Lake. II: 37.

Aj-köl-Mol-Anam. Ma. Name of a Saint. I: 63.

Aj-köl-Mol-Annam-Chodscham. Ma & St. My Holy Man A. K. M. A. I: 67.

Ajrilghan. Con. Point of bifurcation of a river or a road. I: 191; II: 43, 271 ff., 299, 333.

Ajsa-tscheke. Pro. The Promontory of A. II: 604.

Ajs Ullugh-tschapghan. La. A. U's Canal. II: 211.

Ajsu Niasne-köli. La. A. Nia's Lake. II: 211.

Ajtungu-sörutmasi. Lp. A's Canoe-Passage. I: 185.

Ak-arik. Vil. The White Canal. I: 104.

Ak-ato-tagh. Mt. The Mountain of the White Pass. II: 285, 286.

Ak-baj-kuduk. Wl. The Well of the White Man. I: 372.

Ak-bajning-kasch. Dist. The Terrace of the White Man. I: 372.

Ak-basch. Rg. The White Head. II: 6.

Ak-basch-kijak. Fo. tr. A kind of Grass. II: 10.

Ak-basch-tokaj. Stp. The Forest of the White Head. I: 382.

Ak-bel-kum. Dst. The Desert of the White Passes. II: 98, 389 ff., 399, 447.

Ak-bulak. Sp. The White Spring. II: 77, 78.

Ak-daschi. Str. rg. The White Lake. I: 145.

Ak-dung. Hl. The White Hill. I: 65, 89, 183 ff., 502 ff.

Ak-dung-dschaj. Sd. dn. The Place of the White Hill. I: 62.

Ak-dung-tscheke. Vil. The Promontory of the White Hill. II: 513.

Ak-ilek. Str. rg. The White River. I: 301.

Akisch-köl-tscheke. Ho. The Promontory of the Lake Current. II: 513.

Ak-iti-sokkan-tschol. Po. The Pool where the White Dog was Beaten. I: 175.

Ak-jaghatsch. Riv. lp. The White Wood. I: 102; II: 505.

Ak-jantak-kum. Sd. The White Alhagi Sand. I: 94: II: 535.

Ak-jar. Stp. The White Terrace. I: 88.

Ak-jarsik. Riv. lp. The White Lagoon I: 48.

Ak-jarsik. Fo. tr. II: 513.

Ak-jasik. Fo. tr. The White Lagoon. I: 39.

Ak-jasuk. La. The White Lagoon. I: 111.

Ak-jolu-basighi. Str. rg. I: 168.

Ak-katik-arik. Ar. The White Hard (to dig) Canal. I: 428, 505.

Ak-katik-köl. La. The White Hard Lake. II: 511.

Ak-kol. Lp. The White Lake. I: 215, 216.

Ak-kol. La. I: 432.

Ak-kol. La. II: 211.

Ak-kum. Sd. The White Sand. I: 26, 69.

Ak-kum. Dst. I: 40; II: 536.

Ak-kum. Dst. II: 444.

Ak-kumning-jughan-köl. La. The Great Lake in the White Sand. I: 111, 113: II: 537.

Akma-salghan-köbruk. Dist. The Bridge built by A. I: 430.

Akning-koli. La. The White Lake. I: 64.

Akning-kumi. Sd. The White Sand. I: 64.

Ak-ördak-daschi. Fo. tr. The White Duck's Lake. II: 10.

Ak-östäng. Riv. The White Canal. I: 65.

Aksakal-köli. Dry La. The Whitebeard's Lake. I: 423.

Aksak-maral. St. The Lame Stag. I: 21, 25, 54.

Ak-satma. Fo. tr. The White Hut. I: 49; II: 532, 554, 558, 589.

Ak-schor. Stp. The White Salt Marsh. I: 382.

Ak-su. Prov. Oasis. The White Water. I: 92; II: 526.

Ak-su. Tn. The White Water. I: 36, 48 ff., 54, 58 ff., 66 ff., 78 ff., 91 ff., 162, 508; II: 174, 353, 535, 566 ff., 589, 602, 605, 610 ff.

Ak-su-darja. Riv. The River of the White Water. I: 10 ff., 71, 74 ff., 112, 121, 125, 156, 184, 201 II: 189, 309, 353, 449 ff., 458, 516 ff., 521 ff., 554, 566, 569, 570.

Ak Supa Baj-kotan. Ht. The Hut of A. S. B. I: 50.

Ak-tam. Vil. The White Clay House. I: 67.

Ak-tarma. Vil. The White ploughed up Field. I: 168, 229, 435, 510; II: 5, 260, 299, 505.

Ak-tas-dung. Hl. The Hill of the White Stone. I: 390.

Ak-tiken-dung. Fo. tr. The Hill with the Lycium ruthenicum. I: 382.

Ak-tschakil. Str. rg. The White River Loop. I: 80.

Ak-tschol Busrugvar. Ma. The Holy Man of the White Pool. I: 84.

Ala-ajgir. St. hs. The Many-coloured Stallion. I: 18, 19; II: 543, 604.
Alak-nor. La. II: 373.
Alak-tschi. La. II: 371—373. 375.
Ala-kul. La. The Many-coloured Lake. II: 335, 351, 381.
Ala-kum. Sd. The Sporadic Sand. I: 88; II: 534.
Ala Kunglek Busrugvar. Ma. The Holy Man with the Coloured Shirt. I: 92 ff., II: 535, 555, 589.
Ala-schan. Mt. II: 382.
Aleschki. Sd. II: 400
Algaktschi. Fo. tr. The Maker of Sieves. I: 39.
Alim Achuning-ilegi. Old Riv. bd. A. Achun's River. I: 388.
Alim Chodschane-koli. La. A. Chodscha's Lake. II: 211.
Alim Niase Iliasi-dung. Hl. The Hill of A. Nias Ilias. I: 217.
Alim Niasi Iliasidake Muhamede-uji. Des. ho. A. Nias Ilias Muhamed's House. I: 189.
Al-katik-kol. Dry La. Al-katik is a kind of bush. I: 191, 206.
Al-katik-kol. La. I: 416.
Al-katik-tscheke. The Promontory with the Al-katik's. Vil. I: 132, 134, 136; II: 312, 556, 559, 569, 590.
Al-katik-uj. The House with the Al-katik's. Vil. I: 508.
Almontschuk. Chl. The Marten. I: 463, 465; II: 504, 512, 560, 593.
Almontschuk-kok-ala. Chl. The River-branch of the Marten. I: 207 ff.; II: 299, 550, 576, 592.
Altai. Mt. II: 382.
Altan-nor. La. II: 373.
Altimish-bulak. Sp. The Sixty Springs. II: 306.
Altin-kan. Gold and lead mi. The Gold Mines. II: 93.
Altin-tagh. Mt. The Gold Mountain. II: 93.
Altin-tagh. Mts. The Gold Mountains. II: 175, 222, 277.
Alti-schahr. Prov. The Six Towns. I: 383; II: 605.
Altmisch-bulak. Sp. The Sixty Springs. I: 459; II: 4 ff., 63 ff., 74 ff., 88, 91, 104 ff., 110, 118 ff., 127, 165, 170, 174, 222 ff., 235, 307, 324, 466, 493, 520.
Altschuk-bulak. Sp. The Spring of the Little Wood Hut. II: 75, 77.
Altun-keni. Mi. Gold Mines. II: 17.
Altyn-tagh. Mt. The Lower Mountains. II: 260, 261, 307.
Alvandake-ujne-arik. Ca. The Canal of Alvan's House. I: 186.
Amu-darja. Riv. I: 161; II: 333, 360, 404, 427, 444 ff., 451, 522, 528.
Anambar. Vl. II: 472, 475.
Anambaruin-gol. Riv. II: 471 ff., 476, 499, 579.
Anambaruin-ula. Mt. II: 285, 474, 476.
Anar-kol. La. The Lake of the Pomegranates. I: 35, 36.
Andere. Inn. I: 378, 381, 391, 397; II: 217.
Andere-darja. Riv. I: 377, 380.
Andere-terem. Riv. The Cultivated Ground of A. I: 375, 378 ff.
Ansa Kullu-kol. La. The Lake of A. K. I: 507.
Ansane-kolo. Part of a La. The Lake of Ansa. I: 484.
Ansasch-kum. Sd. A's Desert. I: 144; II: 539.
An si. Tn. II: 99, 111, 371, 373 ff. 395.
An-si-fan. Tn. II: 407, 444.
An-si-tschou. Tn. II: 98.
Ansu Kulluning-koli. La. A. Kullu's Lake. II: 513.
Apis-angesi. Pl. The Abandoned Fields of A. I: 431.
Ara-gerem. Vil. The Middle Hut. I: 71.
Ara-koscha. Fo. tr. Between the Two (river-arms); a canal takes its beginning from here. I: 14.
Ara-kum. Vil. The Middle Sand. I: 176.
Ara-kum. Sd. II: 505.
Aral. Str. rg. The Island. I: 80.
Aral. Fo. tr. I: 83, 84.
Aral. Riv. rg. I: 85; II: 589.
Aral. La. II: 203 ff., 349, 360, 368, 391, 445 ff., 522, 528, 554.
Aral-kum. Sd. The Island Sand. I: 151; II: 540.
Aral-toghrak. Fo. tr. The Poplar Island. I: 485.
Araltschi. Fo. tr. The Island-like. I: 13, 16.
Araltschi. Riv. dist. I: 382, 306 ff.
Ara-tarim. Riv. The Middle River. I: 168, 174 ff., 182, 184 ff., 204, 425, 504, 508.
Arelisch. Vil. The Bifurcation. I: 118, 124, 127 ff., 160, 424 ff., 435, 486, 498.
Arelisch. Bif. II: 510.
Arelisch-jasluk-utturghan. Des. ho. The Summer Dwelling-Place of Arelisch. I: 127.
Arghamtschi-baghladi. Str. rg. Where the Rope was Tied. I: 191.
Arghamtschi-baghladi. Bol. I: 206, 207.
Arghamtschi-baghladi-kum. Sd. The Desert of the Tied Rope. I: 100.
Arghamtschi-baghlaghan. Str. rg. The Tied Rope. I: 493.
Arghamtschi-baghlaghan-tscheke. Fo. tr. The Promontory of the Tied Rope. II: 504.
Arghan. Con. The Point of Bifurcation. I: 118, 158, 191 ff., 202 ff., 210, 218, 227, 260, 297, 302, 307, 349, 368, 416, 419, 424, 445, 454 ff., 479, 485 ff., 490 ff., 497 ff., 508; II: 272 ff., 333 ff., 347, 356, 445, 449, 459, 504, 514, 545 ff., 550, 559, 560, 571, 580.
Arik-aghsi. Fo. tr. The Canal Mouth. I: 102; II: 555, 589.
Arik-aghsi-tallikning-satmasi. Fo. tr. & ho. The Hut in the Forest of the Canal Mouth. I: 103.
Arik-baschi. Ho. The Head of the Canal. II: 513.
Arka-darja. Riv. The Farther River. I: 94 ff., 103 ff., 113; II: 536.
Arka-jilgha. Ca. The Farther Narrow Bed. I: 83.
Arka-kol. La. The Farther Lake. I: 304, 472 ff., 487, 489; II: 222, 298 ff., 304 ff., 311, 331 ff., 339 ff., 346, 348, 392, 561, 580, 581.
Arka-kul. Bsn. The Farther Lake. II: 265, 299.
Arkalma. Str. rg. I: 502.
Arka-tagh. Mt. The Farther Mountain. I: 383; II: 141.
Arman-kol. Desic. la. The Worm-wood Lake. I: 94.
Arpa-akin. Riv. The Corn River. I: 65.

Arpa-kumgen-dung. Dn. The Sand-hill of the Corn. I: 169, 170.
Arpa-kumghun-dung. La. The Dug-out Corn Hill; kumghun = dug out, is said of water eddies. I: 432.
Arpalik Fo. tr. The Corn Place. II: 10.
Arpalik-kaja. Fo. tr. The Alluvial Tract where Corn Grows. I: 14.
Arpischme. Sp. The Flourishing Men; because the place had been Desert and because then populated. II: 35, 37 f., 88.
Arsemet-kätgen. Pl. Where A. died. I: 430.
Arsu Beki-dschajiri. Fo. tr. A. B. Little Lake. II: 11.
Arsu Kullu Schek-modschughu. Prm. The Promontory of A. K. S. I: 255.
Arsumet-kona-satmasi. Ht. The old Hut of A. II: 511.
Artilma. Sd. I: 169.
Artschatu. Rg. The Place of the Juniper. II: 285.
Aru-akkan. Ca. The Middle River. I: 216 ff., 481.
Aruk-balik. Fo. tr. The Thin Fish. II: 10.
Aruk-baliklik, or Aruk-balik-jarsik. Fo. tr. The Lagoon of the Thin Fish. II: 10.
Asane-utturghan-koli. La. The Lake where Asa Dwelt. I: 192.
Aschäk-kormatsch-kol. La. The Lake of the Ass Plant. II: 211.
Aschäk-kurmatschlik-kol. La. II: 194.
Aschäk-tumschughi. Fo. tr. The Cape of the Ass. I: 103.
Aschi-dung. Hl. The Open Hill. II: 558.
Aschur Bek-tuschken. Str. rg. Where Aschur Bek encamped. I: 213.
Asghan-bulak. Sp. The Dog-rose Spring. II: 35, 37, 89.
Ashtshi-bulak. Sp. The Salt Spring. II: 472.
Asimet Beki-uji. Sd. dn. A. Bek's House. I: 185.
Asimetgha Vargen-kol. La. A. V's Lake. I: 186.
Asis Bakini-boltasi. Sou. The Sound of A. Baki. I: 294.
Assa. Riv. II: 79, 387, 399.
Assan-tschapghan-tarim. Riv. The River Dug by A. I: 187.
Assa-schahri. Old Tn. II: 38.
Astin-tagh. Mt. The Lower Mountains. I: 364, 383; II: 105 ff., 133, 176, 216 ff., 221 ff., 286 ff., 307, 348, 357, 446, 471 ff., 486, 496, 523 ff., 579, 582.
Asuk-lengeri. St. A's Station I: 67.
At-baschi. Fo. tr. & ho. The Horse's Head. I: 103.
At-jegen. Vil. The Horse Pasturage. I: 423, 493, 498; II: 8.
At-kojmaghan-kol. La. The Lake in which the Horse was not Washed. I: 123.
At-lasch. Vl. Ford. II: 309.
At-oldi. Fo. tr. The Horse Died. I: 67, 73.
At-pangsa. Fo. tr. The Horse Pasturage. I: 18; II: 553, 558, 588.
At-pangsa-tokaj. Fo. tr. The Forest with Horse Pasturage. I: 16.
Atscha-kasch. Fo. tr. The Two Terraces with a Passage between. I: 16.
Atschal. Mth. The Mouth. I: 25.
Atschal. Fo. tr. I: 105.
Atschal. Dist. I: 113.
Atschal. Chl. I: 118.
Atschan. Stm. An Open Place. I: 371.
Atschan. Vl. II: 309.
Atschi-bulak. Sp. The Salt Spring. II: 175.
Atschi-dung. Fo. tr. The Open Passage in the Hills. I: 58 ff., 63, 69; II: 554, 589.
Atschik. Vil. Bitter. I: 8.
Atschik. Riv. I: 113.
Atschik-bulak. Sp. The Salt Spring. II: 35, 37, 38.
Atschik-bulak. Sp. II: 77, 78.
Atschik-bulak. Sp. II: 88.
Atschik-bulak. Os. II: 104.
Atschik-bulak. Sp. II: 218.
Atschik-bulak. Sp. II: 472.
Atschik-darja. Riv. bd. The Bitter River. I: 79, 85, 88, 90 ff., 99, 103, 105, 107, 113, 115, 118, 128, 135 ff., 140 ff.; II: 294, 463, 534 ff.
Atschik-darja. Old Chl. I: 89.
Atschik-jardang-bulak. Sp. The Salt Spring of the Clay Terrace. II: 54, 63.
Atschik-jilgha. Riv. bd. The Salt Narrow Bed. I: 83.
Atschik-kuduk. Dist. The Salt Well. II: 175 ff., 493 ff., 500, 579.
Atschik-su. Sp. The Salt Water. II: 80.
Atschik-sudake-uj. Fo. tr. The House of the Salt Water. I: 502.
Atschik-tarim. Riv. The Salt River. I: 398.
Atschik-uktu. Str. rg. The Salt Lake. I: 175.
Atschi-schipang. Des. riv. bd. The Open Marshy Ground. I: 385.
Atschi-tagh. Mt. The Open Passage in the Mountains. II: 78.
Atta Bajdeni-köl. La. The Lake of A. Baj. I: 449.
Atta Kullunu-ottogho. Ho. The Dwelling-Place of A. Kullu. I: 436.
Attamet-arghaj. Fo. tr. Attamet's Grave. I: 151.
Attamet-koligi. La. A's Lake. II: 505.
Attamet-kologhum. Old la. A's lake. I: 502.
Attamne-koli. La. My Father's Lake. I: 187.
Attamni-dschajiri. Dry la. My Father's Lake; dschajir is ordinarily a little, shallow lake. I: 428.
Ava Bismilning-kok-alasi. Riv. br. The River of A. Bismil. I: 503.
Avat. Vil. Cultivated, Inhabited Place. I: 8, 14.
Avat. Vil. I: 36, 48, 52 ff., 58, 60 ff., 69 ff., 74, 80, 82; II: 604.
Avugh-koli. La. The Lake of A. II: 148, 595.
Avul-akmasi. The Well of A. I: 182.
Avul Ali Bek-katgan-uj. Fo. tr. The Lost House of A. A. B. I: 150.
Avul Alining-kotan-tschekesi. Prm. The Promontory with the Hut of A. Ali. II: 513.
Avul Eselning-uji. Ht. The House of A. Esel. I: 150.
Avul-golme-kadaghan-ilek. Riv. The River where Avul Hung his Net on Poles. I: 482.
Avullu-kol. La. A's Lake. I: 188, 304, 416, 443, 458, 472, 483, 486 ff., 492 ff., 507; II: 9, 43, 53,

221, 208, 304 ff., 311, 330 ff., 341 ff., 344 ff., 348, 356, 392, 519, 548, 561, 580, 581.
Avullu-kul. La. II: 265, 209.
Avulluni-daschi. Po. A's Little Lake. I: 435.
Avulluni-toghu. Fo. tr. A's Dam. I: 436.
Avul Nias Bekne-kakmasi. Bay. The Bay of A. N. Bek. II: 511.
Avul Nias Bekne-kolughu. La. The Lake of A. N. B. I: 182.
Avul Nias Bekni-kakmasi. Bay. The Bay of A. N. B. I: 289, 295.
Avulning-koli. La. Avul's Lake. II: 505.
Avul-päs. Dist. A mans name. I: 434.
Ayrilghan. Con. Bifurcation. II: 272.

Baba-köl. Msh. The Lake of the Grandfather. I: 100, 110; II: 203.
Baba-kol. Dist. & Wl. I: 381.
Babam-bulak. Sp. My Grandfather's Spring. II: 77.
Babamning-koli. La. My Grandfather's Lake. II: 513.
Baban-ullughu. Dist. U. = ambush, thus a place where the grandfather concealed himself when hunting. I: 427.
Baba-tarim. Riv. The Father River. I: 194, 203.
Ba-bulung. Sp. The Bay where Something Exists, i. e. a spring surrounded by Mountains where wild camels exist. II: 78.
Bachtemet. Str. rg. Bachte Muhamed. I: 391.
Bachtemet-lenger. In. Bachte Muhamed's Station. I: 391.
Badschit-tschantschdi. Str. rg. Where B. has Driven down (a pole in the ground). I: 224; II: 593.
Bagha-ghaschon. La. The Little Salt Lake. II: 278, 284, 290, 292 ff., 297.
Bagarash. La. II: 97.
Baghan-Gaschon. La. II: 278, 282, 288, 295.
Baghan-olosu-tai. Rg. II: 287.
Baghrasch-kol. La. I: 457, 499: II: 17, 22, 26, 28, 79, 93 ff., 189, 284, 287 ff., 307, 345, 349 ff., 370, 389 ff., 518 ff., 523, 567.
Bagrash. La. II: 300.
Baj. Vil. The rich. II: 293, 353, 602, 604, 611, 614.
Bajat-kol. La. II: 146.
Bajdan. Mt. II: 97.
Bajin-gol. Riv. II: 370.
Bajini-kolu. La. The Lake of the Rich. I: 168.
Bajin-otak. Sp. The Homestead of B. II: 77.
Bajir. La. Depression. I: 433.
Bajir-kol. La. The Depression Lake. I: 169 ff.; 175, 177, 279, 287, 299, 307, 505.
Bajir-kol. La. (No. 2.) The Depression Lake. I: 299; II: 507 ff.
Bajir-koldake-uj. Vil. The Homestead beside the Depression Lake. I: 169.
Baki Achun-tschapghan. Ar. The Canal of B. A. I: 217.
Baki-kamisch-urghan-kol. La. The Lake where B. has Mown the Reeds. I: 433.
Bakini-boltasi. Sou. Baki's Sound. I: 289.
Bala-ischem. St. II: 454.
Bala-kojdi. Fo. tr. The Child was Laid. I: 103
Balik-jok-kol. La. No Fish Lake. II: 513.
Balik-kumgutsch-kol. La. The Lake where the Fish is Digging (itself down into the bottom-mud). I: 181.
Balıklık-kol. Fo. tr. The Fish Lake. I: 383.
Balik-öldi. Str. rg. The Fish Died. I: 89.
Balkanski Salif. Gf. II: 455.
Balkasch. La. II: 349, 351, 367, 381.
Ban. Sp. II: 90.
Barat Kul's channel. II: 561.
Barat Kulning-koli. La. Barat Kul's Lake. I: 471, 473, 475, 479: II: 506.
Barat-uktesu. Dist. B's Little Lake. I: 430.
Barkeni-arghaji. Ma. Barke's Grave. I: 435.
Basak-kätkän-kol. La. Lake of the Mown Reeds. I: 125.
Basch-aghis. Str. rg. The Upper Mouth. I: 222, 399 ff., 402.
Basch-aktschi. Rg. The First Mouth. I: 67.
Basch-arghan. Str. rg. The Upper Bifurcation. I: 190 ff., 298, 305, 392, 406, 415 ff.; II: 333, 338 ff., 547 ff.
Basch-bulak. Sp. The Uppermost Spring. II: 37.
Basch-jaman-kum. Sd. The Beginning of the Difficult Sand. I: 388.
Basch-karaunelik. Bol. The Upper Black Goose Place. I: 211.
Basch-kol. La. The First Lake. I: 161, 233 ff., 240, 245, 253 ff., 262, 264, 267 ff, 298 ff., 304 ff., 471: II: 190, 335, 514, 572, 579.
Basch-kul. La. I: 228.
Basch-kum-kol. La. The Upper Sand Lake. II: 389, 392, 447.
Basch-kumluk. Sd. The Beginning of the Sand. I: 223.
Basch-kurghan. Ft. The Upper Fortress. II: 471, 472.
Basch-otak. Str. rg. The Upper Dwelling Place. I: 391.
Baschtage-köl. La. The Upper Lake. I: 183 ff., 190, 287 ff., 297, 299, 306; II: 510.
Baschtage-kol (No. 2). La. The Upper Lake. I: 297, 299.
Baschtage-kol (No. 3). La. The Upper Lake. I: 297, 299.
Basch-tam. Riv. br. The Upper Clay Hut. I: 151, 159, 161; II: 569.
Basch-toghrak. Fo. tr. The First Poplar. II: 11, 15 ff., 38, 74.
Basch-uj. Vil. The Upper House. I: 224.
Basra. Tn. I: 155.
Bavan-bulak. Sp. The Hunters' Spring. II: 90.
Bayan-bulak. Sp. II: 278, 285 ff.
Begelik-kol. La. The Lake of the Beks. I: 181 ff., 190, 287 ff., 294 ff., 304 ff., 384; II: 335, 344, 509 ff, 514.
Beglarning-boltasi. La. The Sound of the Beks. I: 288, 294.
Beglik-kol. La. The Lake of the Beks. I: 508.
Bei-schan. Mt. II: 371, 372, 374, 454, 461, 466, 471.
Bej-sän. Mt. The Northern Mountains. II: 99, 100, 102, 110, 111.

Bel-kum. Sd. The Pass Sand. I: 115; II: 537.
Bel-tschapghan. Chl. The Passage Canal (because there are mounds on both sides). II: 136.
Berdischik. Dist. A Man's Name. I: 423.
Bereghes. Fo. tr. I: 18.
Beschik-kaldi. Dist. The Cradle was Left. I: 251.
Bir-ataj. Sp. Where it is possible to Shoot only once (because the camels or other wild animals run away after the first shot). II: 78.
Birintschi-bajir-kol. La. The First Depression Lake. II: 505.
Bisch-arik. St. hs. The Five Canals. I: 71, 72.
Bisch-arik-lenger. St. The Station of the Five Canals. I: 67.
Bisch-bulak. Sp. The Five Springs. II: 75, 77 ff.
Bisch-jol-tschakil. Fo. tr. The River Loop of the Five Roads. I: 16.
Bisch-kajde. Ma. The Five Alluvia. I: 27.
Bisch-kobruk. Rg. Five Bridges. I: 66.
Bisch-köl. Fo. tr. The Five Lakes. I: 16 ff.; II: 558, 588.
Bisch-kol. Rg. I: 66.
Bisch-kol-tarak. La. The Poplar of the Five Lakes. I: 63.
Bisch-kotan. Fo. tr. The Five Huts. I: 47.
Bisch-ostäng. Dist. The Five Canals. I: 65.
Bisch-tarák-kol. Vil. The Lake of the Five Poplars. I: 71.
Bisch-toghrak. Fst. The Five Poplars. II: 512.
Bitschanlik. Str. rg. The Good Grazing. I: 92; II: 569.
Boba-jarsuk. Fo. tr. The Old Man's Lagoon. I: 104.
Bobane-ottogho. Des. vil. The Old Man's Dwelling-place. I: 255.
Bobane-uktusu. La. The Old Man's Little Lake. I: 177.
Boba-uktusu. La. The Old Man's Little Lake. I: 179, 209; II: 503.
Bobo Okuru-kadaghan. Vil. The Enclosure of B. O. I: 511; II: 506.
Bodschante. Salt la. II: 38, 85.
Bogha-achun-lengeri. Vil. B. A's Station. I: 4.
Boghu-baschi. Fo. tr. The Stag's Head. I: 63.
Boghu-baschi. Fo. tr. I: 88.
Boghu-baschi. Fo. tr. I: 216, 457.
Boghuluk. Fo. tr. The Stag Tract. I: 312, 348, 391, 398; II: 174, 307.
Boghu-patti Fo. tr. Where the Stag Sunk. I: 18.
Bolto. Sou. The Sound. I: 251, 255.
Bolto. La. I: 432.
Bore-kitaj. Vil. The Chinese Camel. I: 7.
Boro-balgasun. Tn. II: 380.
Bos-ilek. Riv. The Grey River. I: 425, 486 ff., 490, 492 ff., 498 ff., 507 ff.; II: 9 ff., 52 ff., 343, 345, 513, 519 ff., 548, 561.
Bos-kol. La. The Grey Lake. I: 186 ff.
Bos-köl. La. I: 420.
Bos-kol. Dry la. I: 427 ff., 507; II: 513.
Bos-köl. Bol. I: 435.
Bos-köldake-kona-uj. Hs. The Old House of the Grey Lake. II: 505.
Bos-okte. La. The Grey Little Lake. I: 146.
Bostan. Fo. tr. & ho. The Garden. I: 97; II: 470, 555, 580.
Bostang-nor. La. II: 203.
Bostang-nur. La. II: 284.
Bostan-nor. La. II: 201.
Bostan-Nur. La. II: 287, 300.
Bostan-toghrak. Fo. tr. The Poplar Garden. I: 102.
Bostan-toghrak. Riv. I: 373, 375, 377 ff.; II: 348, 522 ff., 570, 571.
Budschentu. Sp. II: 35, 37.
Budschentu-bulak. Sp. II. 24, 30 ff., 36, 40 ff, 49, 78, 466, 524.
Bughur. Vil. I: 111, 115, 118; II: 203, 600.
Bughur. Mt. II: 97.
Buja-kol. La. B. is a plant. I: 119.
Buja-tagisch. Fo. tr. I: 67.
Buja-tscheke. Fo. tr. The Buja Promontory. I: 115.
Buja-tscheke. Fo. tr. II: 10.
Bujun-kum-tscheke. Ho. The Promontory with the Cape of Sand. II: 513.
Buka-tschapghan. Str. rg. litt: The Bull-Canal: here buka = boghu, tschapghan = dug out Canoe, because a Hunter shot a stag and dug a canoe to carry it down in. I: 398.
Buksem. Fo. tr. II: 606.
Bulak. Ca. Spring. I: 63.
Bulak. La. I: 67.
Bulak. Lg. I: 73.
Bulak. Dist. I: 422.
Bulundsir. Riv. II: 90.
Bulundsir-gol. Riv. II: 98, 176.
Bulungir. Riv. II: 372 ff.
Bulungir-gol. Riv. II: 284, 286, 291.
Bulungir-nor. La. II: 285.
Bulung-otak. Fo. tr. The Dwelling-Place in the Bay. I: 26.
Bulung-su. Ar. The Loop Water. I: 176, 182 ff., 297; II: 546.
Bure Kurban-tscheke. Fo. tr. The Promontory of B. K. II: 513.
Burup-tu. Sp. II: 82.
Buru-tu. Sp. The He-Camel's Spring. II: 63, 75, 88.
Busrugvar. Fo. tr. I: 139; II: 556, 570, 574, 590.
Busrugvar. Ma. II: 556.
Bussup-tuschken-kum. Sd. The Desert where B. Encamped. I: 481.
Busuk Fo. tr. The Restless: i. e. where the River is often changing its bed. I: 84, 87, 86; II: 559, 589.

Central Asia. I: 144, 161, 269, 291, 293, 322, 333, 349, 364; II: 70, 91, 174, 193, 259, 268 ff., 273, 307 ff., 349, 352, 357, 366 ff., 379 ff., 387, 397 ff, 403, 444, 447, 455 ff., 486, 499 ff., 521 ff., 585, 615.
Chadatu-bulak. Sp. The Cliff Spring. II: 285.
Chajdik-gol. Vl. II: 98.
Chajdu-gol. La. II: 391 ff., 516, 518, 523, 525.
Chala-tschi. La. II: 100, 111, 118, 121, 173 ff.
Chalik-tau. Mt. II: 97.
Chalpa. Str. rg. I: 83.

Chami. Tn. II: 475.
Chan-ambal. Vl. See Anambar. II: 472.
Chan-chan. Ctry. II: 312.
Chan Darinning-osesi. Old Ho. C. Darin's Fields. II: 512.
Changaj. Mt. ra. II: 382.
Chang-gung. Smt. I: 427.
Chan-tengri. Mt. II: 461.
Chapa. Fo. tr. I: 61.
Chara-narin-ula. Mt. ra. II: 384, 441.
Chara-nor La. Black Lake. II: 100, 118, 173, 222, 284, 287 ff., 372, 381, 386, 524.
Chara-nur. La. II: 287, 291.
Chara-teken-ula. Mt. ch. II: 26, 70, 94 ff., 98, 301.
Charman-tala. Pa. gr. The Threshing-plane. I: 65.
Chat-kojdi-tscheke. Prm. The Promontory where the Letter was Left. II: 513.
Cherchen. Tn. II: 307.
Cherchen-darja. Riv. II: 261.
China. II: 260, 264, 269, 290, 295, 509.
Chingan. Mt. II: 380 ff.
Chirki-darja. Riv. Chirki's River. I: 126.
Chivilik-kul. La. The Lake of the Mosquito Net. II: 264.
Chodai Vardi-kalmakgha-til-vargen. Fo. tr. The Place where Chodai Vardi talked with a Kalmuck. I: 209.
Chodai Vardi-tschapghan. Ca. C. V's Canal. I: 175.
Chodai Vardi-tschapghan. Ar. I: 508.
Chodai Vardi-uktusu. Old la. C. V's Little Lake. I: 187.
Chodscha-Jaghan-köl. Bol. C. J's Lake. I: 210.
Chodschaji Kisi-masar. Ma. The Tomb of the Lord's Daughters. I: 427.
Chodscha-julghun. Os. The Lord's Tamarisk. II: 79.
Chodschak-köl. La. I: 111.
Chodscha Kulluning-uj. Ca. The House of C. Kullu. II: 510.
Chodscha Kullu-tagirman-kok-alasi. Chl. The Canal of C. K's Mill. I: 505.
Chodscham-jarni-uji. Sa. My Lord's House on the Terrace. I: 485.
Chodscham Kaldining-tongusluk-uji. Hs. C. Kaldi's House in the Boar Tract. II: 505.
Chodscha-schukur. Sp. My blessed Lord. II: 471, 472.
Chodscha-tutghan-kol. La. The Lake where C. was Caught. II: 512.
Chodscheli-boltoso. Sou. C's Sound. I: 251.
Chodscheli-kakmasi. Bay. C's Bay. I: 281.
Chodscheli-modschughu. Cp. C's Cape. I: 251, 255.
Chodscheli-modschuk. Cp. I: 281.
Chodschem Kullunu-uji. Ho. C. Kullu's House. I: 436.
Chodschem Vardi-kol. La. C. V's Lake. I: 432.
Chon-kul. La. The Big Lake. II: 262.
Choras-oldi. Dist. Where the cock died. I: 83.
Chor-chi-tse. Os. II: 371, 374.
Chorum. Old riv.-a. II: 530.
Chotan. Tn. I: 80, 82, 150, 360, 510; II: 264, 267, 272, 293, 353, 367, 382, 526, 567, 570, 599, 601, 605, 610.
Chotan-darja. Riv. I: 16, 69, 74, 77 ff., 87, 91, 100, 112, 303, 328 ff., 363 ff., 378 ff., 394, 411; II: 10, 189, 221, 309, 348, 350, 370, 383, 387, 440, 455, 457 ff., 517, 521 ff., 525 ff., 534, 565, 567, 569, 606 ff.
Chotan-kemisi. Fo. tr. Tr. r. & Fd. The Chotan Ferry I: 82, 83, 91, 96.
Chua-chai-tsi. La. II: 371, 372, 373, 374 375, 376.
Chua-ma-tschen. Tn. II: 380.
Chuntei-nor. La. Man Lake. II: 285.
Chura-taurum. Os. The Dry Place. II: 82.
Churtuk-tau. Mt. II: 96.
Ciarcian. Tn. II: 301.

Daban-sjan. Rge. II: 373.
Dabusun-nur. La. II: 284.
Dadani ottogho. Ht. The Dwelling Place of the Uncle. I: 177.
Da-dung. II: 37.
Daghi. Dist. I: 106. II: 555.
Daghi-kotan. Fo. tr. I: 110.
Dalai-khuduk. Wl. The Sea Well. II: 291.
Dalal-uji. Pl. I: 430.
Dangaltschi. Vil. I: 6.
Dangsur-kol. La. I: 159, 200.
Dankan-tscholi. Fo. tr. I: 26.
Dap-karan. Br. Rejected; about a broken canoe. I: 465.
Darja-kosch. Str. rg. The Double River. I: 387.
Darghalik. Fo. tr. The Place of the White, Dry Poplar-Wood. II: 11.
Dargh-ilek. Pl. The River-arm of the White, Dry Poplar-Wood. I: 490, 509.
Daschi. Fo. tr. The Salt Lake. I: 18.
Daschi. Vil. I: 149.
Daschi. Ho. II: 513.
Daschi-kol. La. The Lake of the Salt Pool. I: 140, 169, 230 ff, 298; II: 510.
Daschi-kol. La. I: 512.
Dasch-kol. La. I: 161.
Da-so-cho. II: 38.
Dastar. Fo. tr. I: 97, 102.
Dauleti-boltoso. Sou. Daulet's Sound. I: 469.
Daulet Kismak-kurghan. Hl. D. K's Fortress. I: 485.
Davan. Ps. Pass. II: 22, 38, 95.
Davan. Sd. The Pass. I: 431. II: 281.
Davaning-koli. Dry la. The Lake of the Pass. I: 431.
Dga. Vil. II: 70, 82, 84 ff., 387, 399.
Dighaj. Vil. II: 85.
Dilgerning-uji. Dilger's House. II: 505.
Dilgi. Dist. I: 490.
Dilpar. Dist. Water Lily. II: 6 ff., 21, 96, 518 ff.
Dimen-tokaj. Fo. tr. D's Forest. I: 390.
Dindiosen. Mt. II: 90.
Doschotu-arghaji. La. D's Grave. I: 432.
Dötschun. Old rd st. I: 67.
Dotschun Dist. I: 59.
Dötö. Fo. tr. Döto is a place where a river has abandoned a loop or winding and cut itself a straight new bed. I: 412; II: 337.

Doto. Fo. tr. II: 10.
Dovlet Bajini-uji. Ho. The House of D. Baj. I: 168.
Dovlet-tareghan. Pl. Where D. was Cultivating his Fields. I: 430.
Dschahan-saj. Trt. The Valley of D. II: 283.
Dschajde-lenger. St. The Station-house of the Grave. I: 67.
Dschaj-dung. Hl. The Hilly Place. I: 111, 118.
Dschajir-kol. Msh. The Lake of the Pool. I: 470.
Dschaj-kum-masarim. Ma. My Tomb in the Sand. I: 66.
Dschaj-toghrak-ikki-Dschan-Pena-Chodscham. Ma. The Poplar Place of My Lord's the two D. P. I: 67.
Dscham-kojghan-tscheke. Prm. The Promontory where the Cup was Laid. II: 505.
Dschan Kuli-örtäng. St. The Station of Dschan Kuli. II: 5.
Dschan Kullu. La. A Man's Name. I: 433.
Dschan Kullu. Csai. I: 436.
Dschan Kulu (or Kuli). Des. vil. II: 5.
Dschan Nias. La. A Mans Name. I: 175.
Dschan Nias-kol. La. Lake of D. N. I: 287.
Dschan Nias-kol. La. II: 507 ff.
Dschan Niasning-satmasi. Des. vil. The Hut of D. Nias. II: 507.
Dschindar-kol. La. I: 115, 116.
Dschiseken. II: 296.
Dscho-bi-sen. Mt. II: 37.
Dscho-bulak. Sp. The Lhasa Spring. II: 471.
Dsookha. Vil. II: 285.
Dsucha. Vil. II: 285.
Dsungaria. Prov. II: 307.
Dugha-dschaji. Fo. tr. The Grave with the Tamarisk Flowers. I: 49 ff.. 65; II: 532, 554, 558, 589.
Dugha-dschaji. Sd. dn. I: 69.
Dughulge-kok-kol. La. II: 510.
Dukan-toghrak. Fo. tr. The Poplar of D. (a man's name); d. also = loom. I: 18.
Dukan-tusu. Dist. The Plane of D. I: 434.
Dumbol. Riv. I: 107.
Dumbol-darja. Riv. I: 109, 118.
Dun-chuan. Tn. II: 373 ff., 380.
Dun-da-sen. Mt. The Eastern Great Mountains. II: 37.
Dundiosen. Mt. Dun-da-sen = The Eastern Great Mountain. II: 38.
Dung-aghil. Str. rg. The Shepherd's Camp of the Hill. I: 391; II: 571.
Dung-aghil. Fo. tr. II: 217.
Dung-chan. Tn. See Tung-chuan. II: 15, 147.
Dung-chan-jol. Rd. Road to Tung-chuan. II: 148, 150
Dung-gerem. Fo. tr. The Earth-hut of the Hill. I: 58; II: 554.
Dung-gerem. Sd. II: 533.
Dung-kischlak. Str. rg. The Winter Camp amongst the Hills. I: 80.
Dung-kotan. Ht. The Hut on the Hill. I: 65.
Dung-kotan. Fo. tr. I: 98, 110 ff., 113, 116, 118.
Dung-kotan. Sd. dn. II: 535.
Dung-kotan-tscheke. Vil. The Promontory of the Hut on the Hill. II: 513.
Dunglik. Wl. The Hilly Region. I: 388; II: 148, 216 ff.
Dunglik-kol. La. The Lake of the Hilly Region. I: 469.
Dungluk. Rg. The Hilly Region. II: 471.
Dungluk-kol. La. The Lake of the Hilly Region. II: 511.
Dung-otak. Fo. tr. The Homestead of the Hill. II: 10.
Dung-otak. Rg. II: 503.
Dung-sarat. Ma. The Tomb on the Hill. I: 55, 67.
Dung-satma. Ho. The Hut on the Hill. I: 107, 110.
Dungu-tuva. La. The Lake beside the Hill I: 432.
Dural. Tn. A Place Touched by a River Loop. I: 111, 115, 427 ff., 502 ff., 508; II: 5, 37, 505, 608.
Duralning-köli. La. The Lake of Dural. I: 505.
Durga nor. La. II: 381.
Dutschin. Old rd. st. I: 67.

Ebi-nor. La. II: 381.
Ebuduk. St. II: 291.
Edsinei. Riv. II: 277.
Edsin-gol. Riv. II: 382.
Eger-davan. Ps. The Saddle Pass. II: 77.
Egertschi. Ps. The Saddle-Maker. II: 37 ff., 77.
Egertschi-tagh. Mt. ra. The Mountain of the Saddle-Maker. II: 86.
Egri-jar. Lp. The Irregular Terrace. I: 83.
Egri-köl. La. The Irregular Lake. II: 513.
Egri-toghrak. Fo. tr. The Crooked Poplar. I: 97.
Ejsa Kullu Aksakal-ottogho. Str. rg. The Homestead of E. K. A. I: 224.
Ejsaning-kakmasi. Bay. The Bay of Ejsa. II: 508.
El-goléa. II: 397.
Emin Achune-uktusu. La. E. Achun's Little Lake. I: 166, 244 ff., 251 ff., 262, 267.
Empen. Old Tn. See Jim-pen. II: 30, 34, 36, 38, 41, 582.
Erg. Dst. II: 396, 397, 403, 436.
Eski-darja. Old riv. The Old River. I: 14.
Eski-schahr. Ru. The Old Town II: 34, 39.
Eski-tarim. Old chl. The Old River. I: 176.
Eski-tarim. Riv. II: 546.
Ettek-bair. La. The Western Bajir. I: 228.
Ettek-bajir. Ba. The Western Bajir. I: 228, 299, 307.
Ettek-kol. La. The Western Lake. I: 185, 191, 297, 299, 307; II: 561.
Ettek-sala. Riv. br. The Western River-arm. I: 487, 488, 490, 492.
Ettek-tarim. Riv. The Western River. I: 138, 100 ff., 207, 302, 363, 380, 392, 395, 399, 402 ff., 416, 439 ff., 445, 457, 488; II: 272, 301 ff., 335, 337, 345, 462, 465, 512, 547, 571.

Fajs-abad. Vil. St. Place of Benediction. I: 4, 7 ff.; II: 604, 605.

Fajs-abad-darjasi. Stm. The River of the Place of Benediction. I: 5.
Fezzan. II: 307.
Fu-ye-ye. II: 305.
Fu-Zhi Hai. La. II: 300.

Gadaj-tschapghan. G's Canal. (Place of the Lower Tarim; not in the Text.)
Gädschir. Dist. I: 90; II: 555.
Gadschir. Sd. dn. II: 536.
Gais Bek-temi. Ht. The Clay House of G. B. I: 80.
Galechan-bulak. Sp. II: 472.
Ganges. Riv. II: 333.
Gansichin-toghrak. Dry bd. The Solitary Poplar. II: 90.
Gan-su. Prov. II: 380.
Gan-tscheo. Tn. II: 382.
Gao-taj. Tn. II: 380, 382.
Gara Krima. II: 460.
Gas. La. See Ghas. II: 278.
Gaschiun-tsuche. Vl. II: 380.
Gaschun-nor. La. The Salt Lake. II: 285.
Gas-nor. La. The Goose Lake. II: 278.
Gass. La. Goose. II: 279.
Gast. Ps. See Ghas. II: 262.
Gen-deng. St. hs. II: 505.
Gendeng. In. I: 499.
Gen-so-chola. Des. st. The Great Good Pasturage. II: 37, 38.
Genso-cholo. II: 38.
Genso-cholo. Sp. II: 86.
Gentej. Mt. ra. II: 382.
Geremdake-kol. La. The Lake of the Hut; a gerem is dug out in the ground and then covered with branches and kamish. I: 182.
Gerilghan. Fo. tr. G. = ajrilghan; because an old road to Korla diverged here from the Kontsche-darja. II: 10, 96, 302.
Ges-darja. Riv. G. a Plant. I: 6 ff.; II: 533.
Ghadaj-tschapghan. La. G's Canal. I: 416.
Ghadamès. Os. II: 397.
Ghaib Vardi-uji. Des. ho. The House of G. V. I: 177.
Ghansechen-toghrak. Os. II: 77.
Ghapan-uji. Ho. I: 182.
Gharvane-tokkan. Str. rg. Where G. was borne. I: 118.
Ghas. La. Goose. II: 280, 281, 285, 286.
Ghasanglik. Fo. tr. Heap of Poplar Leaves. I: 14, II: 588.
Ghas-asti. Fo. tr. The Suspended Goose. I: 106.
Ghas-atti. Ppr gr. Where the Goose was Shot. I: 89.
Ghascha. Fo. tr. I: 52.
Ghascha. Stp. II: 532.
Ghaschiun-nor. La. Salt Lake. II: 382.
Ghaschon. La. Salt Lake. II: 285.
Ghaschun-Gobi. Dst. The Salt Desert. II: 83, 110, 117, 118, 121.
Ghaschun-ula. Mt. The Salt Mountain. II: 118.
Ghas-kol. La. The Goose Lake. I: 350.
Ghaslik. Fo. tr. The Goose Region. I: 26.
Ghas-nor. La. The Goose Lake. II: 281.
Ghatschilik. Fo. tr. Ghatschi is a plant. I: 390.
Ghesi-gumbes. Ma. The Tomb of G. I: 55.
Ghilam-kol. La. The Carpet Lake. I: 463.
Ghilangdake-uj. Des. ho. The House in the Open Place. I: 182.
Ghilange-kolu. La. The Naked Lake. I: 182.
Ghirlang. Fo. tr. I: 48.
Ghischi-kotan. Fo. tr. The Hut in the Kamish-region. I: 108.
Ghobi-schakschikho. II: 285.
Ghobi-tulatu. St. II: 285.
Ghodajlik-kol. La. The Swan Lake. I: 192, 204.
Ghodsche-tutghutsch-kol. La. Where the Feathers of the Wild Duck were Gathered. I: 297, 299, 307; II: 512.
Ghol-kol. La. The Middle Lake. I: 288, 294 ff.
Ghol-kol. La. II: 138.
Ghol-kol. La. II: 510, 511.
Ghol-sala. Riv. br. The Middle River-arm. I: 487, 492.
Ghorun-dung. Hl. I: 23.
Ghorung-dung. Sd. dn. II: 530.
Ghudschek-sapi. La. The Oar Pole. I: 433.
Ghuma. Tn. II: 605.
Ghun-ilek. Riv. The Deep River. I: 492.
Ghun-kol. La. The Deep Lake. I: 416.
Ghun-koruk. Str. rg. The Deep Lagoon. I: 224.
Gilang. La. The Naked, the Open. I: 503, 505.
Gildermak. II: 512.
Girlang-kol. La. II: 512.
Gobi. Dst. I: 512; II: 98 ff., 103 ff., 111, 148, 174, 379, 381 ff., 385, 395, 400, 427, 441, 443, 459, 467 ff., 471, 487, 489, 499, 579, 580.
Godsche-tutghutsch-kol. La. The Lake where Feathers were Taken. I: 186.
Goletschen. Sp. II: 471.
Golme-kadaghan. Ca. The Net Bound to Poles. I: 288.
Golme-käti. La. The Lost Net. I: 166, 168, 238 ff., 250 ff., 265 ff., 276, 279 ff., 287, 296 ff.; II: 335, 344.
Golme-käti (n:r 2). La. I: 299, 304, 306 ff.; II: 509.
Golme-katgen-kol. La. The Lake of the Lost Fishing-net. II: 148, 149.
Golme-kati-kol La. The Lake of the Lost Net. I: 244, 298.
Goro-tschol. Cly. The G. Desert. I: 71, 73.
Goro-tschol-kemisi. Fd. Boat of the G. Desert. I: 80.
Gueurn Abd el-Kader. II: 397, 403.
Gueurn el-Chouf. II: 397, 403.
Gullik-kol. La. The Lake of the Flowers. I: 67.
Güntei-bughora. St. The Dark Male Camel. II: 285.
Gurkur. Fo. tr. The Cataracts. I: 89, 433.
Gu-schi. Kdm. II: 264.

Habdan-Busrugvar. Ma. Masar. I: 9.
Hadik-gol. Riv. I: 400.
Hadschi-kum. Fo. tr. The Mekka Pilgrim's Desert. I: 26.

Hadschi Nam. Ma. A Saint's Name. I: 105.
Hadschi Nam. Fo. tr. I: 100.
Haghena-bulak. Sp. The Spring of the Wild Buck. II: 77.
Haid Kullu-dung. Hl. The Hill of H. K. I: 502.
Hamdan-kol. La. H's Lake. I: 84.
Hamdan-surasi. Fo. tr. H's Hut. I: 90.
Hami. Tn. II: 70, 98 ff., 104, 110 ff., 118 ff.
Hangetlik. Fo. tr. Where Gulls are abundant. I: 72; II: 554, 559, 580.
Han-hai. Bsn. II: 307 ff., 443.
Haradighan-kotak. Fo. tr. The Dry Sawn Wood. I: 28; II: 554, 558, 588, 590, 591.
Harràlik. Fo. tr. The Place of the Black Beetle. I: 61; II: 569.
Hasanak-darja. Riv. II: 536.
Häsemet-tokaj. Fo. tr. I: 97.
Haser. Fo. tr. I: 39.
Haser-kol. La. The Lake of H. I: 43.
Haser-òlgen. Ppr. gr. Where H. died. I: 435.
Haser-olgen-uj. The House of the Dead H. II: 505.
Hasret Ali. Mt. I: 41.
Hasret-Ali-Masar. Mt. The Tomb of the Holy Ali. I: 34; II: 531.
Hassaj-schahr. Ru. The Town of H. II: 37.
Hattim Schah. La. A Man's Name. I: 64.
Hattim Schah-kol. La. The Lake of H. S. I: 65.
Heibulla. Fo. tr. A Man's Name. 62.
Hejtmet Mirabning-lengeri. St. Hs. The Station of H. Mirab. II: 503.
Himalaya. Mts. II: 76.
Hoang-ho. Riv. The Yellow River. II: 260.
Hollusun-nor. La. The Reed Lake. II: 284, 370.
Hugli. Riv. a. II: 333.
Hunglughu. Gn. II: 176, 471.
Hwang-ho. Riv. The Yellow River. II: 333, 336, 355, 380, 384, 441, 550.

Ibrahim Hakim-lengeri. Vil. St. The Station of Doctor Ibrahim. I: 71.
Idek-ilek. Stm. The Stinking River. I: 435.
Ifane Kullu-kol. La. Lake of I. K. II: 218.
Igertschi-tagh. Mt. The Mountain of the Saddle-Maker. II: 38, 86, 95.
Ighis-dung. Sd. The High Hill. I: 169 ff., 231.
Igis-uj. Fo. tr. The High House. I: 126.
Ike Durbeldschin. St. The Great Four-square. II: 291.
Ike-ghaschon. La. The Big Salt Lake. II: 278, 282, 284, 287, 290, 292 ff., 297.
Ike-tsohan-gol. Riv. II: 284, 285.
Ikintschi-bajir-kol. La. The Second Depression Lake. II: 505.
Ikki Dschan Pena Masar Chodscham. Ma. The Masar of My Lord's the two D. P. I: 49.
Ilanlik. Pl. The Serpent Place. I: 65.
Ilchuma. Mt. II: 110.
Ilek. Riv. I: 149, 182, 204, 207 ff., 274, 406, 411, 425 ff., 433, 444, 451, 454, 463 ff., 477 ff., 484 ff., 492, 496, 498, 507, 509; II. 53, 221 ff., 264, 299, 302 ff., 311, 330 ff., 339, 343, 345 ff., 356, 548, 550, 556, 561, 576, 580, 581, 590, 596.
Ilek-kol. La. The Lake of the River. I: 147.
Ilek-(Tokus-tarim). Riv. II: 330.
Ilias-bajiri. Ba. The Depression Lake of I. I: 277, 285; II: 506.
Iliasi-koli. La. I's Lake. I: 144.
Ilias Murabne-mahalla. Vil. The Village of I. Murab. I: 168.
Ilias Murabne-modschughu. Cp. The Cape of I. M. I: 281.
Ilias Murabne-salghan. Cp. Place Founded by I. M. I: 278, 281.
Ilias Murab-salghan. Sh. tr. I: 255.
Ilias Murab-salghan-jer. Sh. tr. The Place Settled by Ilias Murab. I: 281.
Ilkitschi-ojle. Vil. The Village of the Horseherd. I: 6.
Iltirghan. Sp. & Gn. The Killed. II: 70 ff., 83.
Iltirghan-bulak. Sp. The Spring of the Killed. II: 84.
Iltirghusch. The Slowly Running Rivulet. II: 77, 84.
Iltirghutsch-ause. Gn. The Mouth of the Slowly Running Rivulet. II: 70.
Iltschi. Tn. The Messenger. II: 597, 611.
Imam Bet Ali Ghasim. Ma. & Vil. A Saint's Name. I: 73.
Imam Bet Ali Ghasim-masar. Ma. The Tomb of I. B. A. G. I: 80.
Imam Naserning-uj.-ak-kum. Sd. Imam Naser's Homestead in the White Sand. I: 120.
Imam Padischahim-kemisi Fd. I. P's Canoe. I: 80.
In-pan-fu-tsi. II: 374.
In-schan. Mt. ra. II: 382.
Intschka. Fo. tr. The Narrow I: 96, 104; II: 470, 555, 559, 569, 589.
Intschkä-darja. Riv. The Narrow River. I: 102, 104, 107, 109, 111, 150, 157, 508; II: 10, 527, 536, 606.
Intschkädige-tam. Fo. tr. The Clay Hut of the Narrow Place. I: 83, 156.
Irete-kojghan. Str. rg. The Grave of I. I: 502.
Isangan. Str. I: 371.
Ischtan-asti-kol. La. The Lake of the Suspended Trousers. I: 111.
Ischtan-salghutsch. Bol. Where the Trousers were Laid. I: 423.
Ischtan-salghutsch. Des. vil. I: 423.
Isengan. Vl. II: 309.
Iskatka Vardi-kol. Old la. The Lake of I. V. I: 183.
Islam-abad. Vil. II: 604.
Islam Jussul-uji. Ht. I. J's House. I: 427.
Islam Käldini-modschughu. Cp. The Cape of I. Kaldi. I: 281.
Islam Niasning-koli. La. I. Nia's Lake. II: 508, 509.
Islamning-uji. Ho. Islam's House. I: 472, 474, 475, 476; II: 561, 594, 596.
Islik. Fo. tr. The Smoky Place. I: 53; II: 554, 558, 589.
Ismail Achun-kok-alasi. Chl. I. A's River Branch. I: 506.
Ismail Bajning-uji-tscheke. Ho. The Promontory with I. Baj's House. II: 513.
Ismaile-arighi. Chl. Ismail's Canal. I: 182.

Issik-kol. La. The Hot Lake. II: 349.
Issik-otak. Fo. tr. The Hot Place. I: 383.
Istam Begi-kadasi. Dist. The Pole of I. Beg. I: 288.
Istam Begi-markati. Ma. The Masar of I. Beg. I: 185.
Istam-tschapghan. Chl. Istam's Canal. II: 146.

Jachijani-uji. Des. ho. Jachija's House. I: 186.
Jachija-tschapti-kol. Bol. The Lake Dug out by J. I: 423.
Jaghatsch-alghutsch. La. Where Wood was taken. I: 432.
Jaghatschlik-kol. La. The Wood Lake. I: 111.
Jaghisma-kol. La. II: 194, 209.
Jaghlik-tschokken-tscheke. The Promontory where the Grease was lost in the River. II: 504.
Jaghlik-tschokon-otak. Po. I: 206.
Jajdi. Fo. tr. II: 569.
Jajir-kol. La. I: 141.
Jajlak. Dist. & vil. The Summer-Place. I: 4, 5.
Jaka-atscha. Chl. The Last Channel. I: 183.
Jaka-jardang-bulak. Sp. The Last Terrace Spring. II: 54 ff., 235.
Jak-akkan. Fo. tr. The Streaming Oil. I: 382.
Jak-akkan-kum. Sd. The Desert of the Streaming Oil. I: 382.
Jakakning-kum. Sd. I: 382.
Jaka-kol. Str. rg. The Last Lake. I: 118, 147.
Jaka-kuduk. Rg. The Last Well. I: 55.
Jaka-kuduk. Vil. The Last (or farthest) Well. I: 66, 67.
Jäkän-boldschemal. Bol. The Deadwater of the Sedge. I: 404 ff.; II: 504.
Jakän-köl. La. The Sedge Lake. I: 111.
Jäkän-kol-tscheke. The Promontory of the Sedge Lake. II: 513.
Jakänlik. Vil. The Sedge Place. I: 181.
Jakänlik. Str. rg. I: 502.
Jakänlik. Fo. tr. II: 10.
Jakänlik-boldschemal. Ltl. bd. The Deadwater of the Sedges. I: 213.
Jäkanlik-dschaji. La. The Sedge Lake. I: 187.
Jakänlik-kol. La. The Sedge Lake. I: 115 ff.
Jakänlik-kol. La. I: 181 ff., 287, 289, 296.
Jäkänlik-köl. Dry la. I: 422, 426 ff.
Jakanlik-kol. La. II: 143.
Jakänlik-kol. La. II: 146.
Jakanlik-kol. La. II: 148.
Jakänlik-köl. La. II: 210.
Jakanlik-tuschkun. Str. rg. The Sedge Loop. I: 213.
Jakan-oj. Vil. The Sedge House. I: 449, 450, 451, 455, 457; II: 596.
Jakan-ok(u)luk. The Stalk of Sedge. II: 510, 512.
Jakan-okuluk-uj. Str. rg. The House of the Sedge Stalks. I: 420.
Jaka-toghrak. Pl. The Last Poplar. I: 370.
Ja-kotan. Bol. The Hut on the Terrace. I: 200; II: 554.
Jakub Baj-kuduk. Wl. Jakub Bek's Well. I: 398.
Jalang-dschajir. La. The Open Little Lake. I: 287; II: 506 ff.
Jalghus-jigde. Fo. tr. The Solitary Eleagnus. I: 26, 457; II: 553, 558, 588.
Jalghus-jigdedake-uj. Ht. The House of the Solitary Eleagnus. I: 214.
Jalghus-tal-jingpang. Fo. tr. The Wall of the Solitary Willow. I: 53.
Jalghus-toghrak. Fo. tr. The Solitary Poplar. I: 111.
Jalghus-toghrak. Sd. & tms. I: 159.
Jalghus-toghrak. Str. rg. I: 493.
Jalghus-toghrak. II: 505.
Jallang-dschajir. La. The Open Little Lake. I: 173 ff., 299, 307.
Jam-alghan. Fo. tr. Taken by J. I: 145.
Jamal-tüschdi. Fo. tr. Where J. camped; J. was a rich Man from Shah-jar. I: 72.
Jamandake-uj. Old vil. The Bad House. I: 168.
Jaman-darschi. Rg. The Bad Pool. I: 67.
Jaman-dasch. Fo. tr. The Bad Salt Pool. I: 63.
Jaman-ilek. Riv. a. The Difficult River (because of its many windings). I: 435 ff.; II: 5 ff., 11.
Jaman-jajir. La. I: 432.
Jaman-kum. Sd. The Horrid Sand. I: 380.
Jaman-osa. Sd. The Bad Field. I: 115.
Jaman-tala. Dist. The Difficult Desert. I: 430.
Jaman-talaning-baschi. Dist. The Beginning of the Difficult Desert. I: 430.
Jaman-tokaj. Fo. tr. The Bad Forest. I: 26.
Jan-bulak. Sp. II: 77, 387, 399, 472.
Jan-daschkak. Wl. Where one has to pass near something f. i. a hill. II: 216 ff.
Janek. Sd. hl. I: 485.
Janek-baschini-arelisch. Str. rg. I: 485.
Jangal-kotan. Ht. The Forest Hut. I: 65.
Jangi-Abdal. Vil. The newly Inhabited Place. II: 152.
Jangi-arik. Vil. The New Canal. I: 6, 7.
Jangi-avat. Vil. The newly Inhabited Place. I: 63, 67.
Jangi-darja. Riv. The New River. I: 14.
Jangi-darja. Riv. I: 25.
Jangi-darja. St. I: 67.
Jangi-darja. Riv. I: 71.
Jangi-darja. Riv. I: 88, 90 ff.
Jangi-darja. I: 121.
Jangi-darja. I: 139.
Jangi-darja. Riv. II: 535.
Jangi-hissar. Tn. The New Fortress. II: 605, 611.
Jangi-jer. La. The New Place. I: 440, 445, 454 ff.; II: 130, 167 ff., 211, 215, 595.
Jangi-kol. Vil. The New Lake. I: 161, 166, 168, 204, 233 ff., 270, 508, 510; II: 550, 571, 572, 576.
Jangi-köl. La. I: 161 ff., 178, 233 ff., 242, 251 ff., 260, 264 ff., 286, 298 ff., 304 ff., 312, 333, 350, 354, 360, 368, 383 ff., 410, 419, 425, 432, 536 ff., 493, 512; II: 5, 11, 15, 52, 137, 141, 161, 205, 208, 211, 335, 354, 435, 438, 459, 503 ff., 545, 548 ff., 556, 586 f., 590 f.
Jangi-kol. Po. I: 214.
Jangi-kol. Dry la. I: 224.
Jangi-kol. Dist. I: 433.
Jangi-koldake-kona-uj. Old vil. The Old House of the New Lake. I: 168.

Jangi-kul. La. The New Lake. I: 228.
Jangi-östäng. Ar. The New Canal. I: 370.
Jangi-schahr (The New Town) of Jarkent. II: 614.
Jangi-schahr of Kaschgar. I: 3 ff.
Jangi-schahr of Ak-su. Tn. I: 67, 71; II: 509.
Jangi-su. Vil. The New Water. I: 185 ff, 227, 425, 493.
Jangi-su. La. II: 511.
Jangi-sudake-kol. La. The Lake of the New Water. I: 185.
Jangi-sudake-kona-uj. Des. vil. The Old House of the New Water. I: 185.
Jangi-su-mähallä. Vil. The Village of the New Water. II: 511.
Jangi-suning-kol-aghsi. La. The Mouth of the New Water's Lake. II: 511.
Jangi-tarim. Stm. The New River. I: 468.
Jangi tarim. Chl. I: 481, 482.
Jangi-tarim. Riv. br. I: 487, 488.
Jangi-tarim. Riv. II: 343.
Jangi-tarimning-ilek. Ca. The River Arm of the New River. I: 481.
Jangi-terem. Pl. The New Settlements. I: 385.
Jangi-uj. Rg The New House. II: 580, 581.
Janijas-jatghan. La. J's Grave. I: 432.
Janje. Vil. I: 7.
Jan Kulligha Värgen-tarim. Old chl. J. K. V's River. I: 186.
Jantak-alghutsch. Str. rg. Where Alhagi is Gathered. I: 502.
Jantak-alghutsch-osasi-arighi. Ca. The Canal of the Field where Alhagi is Gathered. I: 185.
Jantak-kol. Lg. The Lake of Alhagi Camelorum. I: 48 ff.
Jantak-kol. La. II: 532.
Jantak-kol-aghsi. Riv. The Mouth of the Alhagi Lake. I: 48.
Jantak-kuduk. Wl. The Alhagi Well. I: 371, 372.
Jantaklik-kol. La. The Alhagi Lake. I: 50, 127.
Jantak-tscheke. The Alhagi Promontory. II: 513.
Japma-notscha. Fo. tr. I: 103.
Japtschanlik-kol. La. The Lake of the J. (a plant). I: 383.
Jar-aghil. Stp. The (Shepherd's) Camp on the Terrace. I: 382.
Jar-aghilning-kum. Sd. The Desert of the Camp on the Terrace. I: 382.
Jardang. Fo. tr. The Clay Terrace. II: 10.
Jardang-bulak. Sp. The Spring of the Clay Terrace. II: 4, 53 ff., 76.
Jarghutschak-kumdi. Fo. tr. The Hollowed out Hand-Mill. I: 140.
Jar-jeghan-ak-kum. Sd. The Eroded Terrace of the White Sand. II: 537.
Jar-jeghan-kum. Sd. The Sand of the Eaten away Bank. I: 124.
Jarkent. Dist. & Tn. The Town upon the Terrace. I: 10, 15, 58, 67, 76, 78, 91, 100, 125 ff., 351; II: 353, 382, 450, 542 ff., 569, 570, 582, 600 ff., 604 ff, 610 ff.
Jarkent-darja. Riv. I: 10 ff., 19, 21 ff., 26 ff., 34 ff., 49 ff., 63 ff., 87 ff., 98, 100 ff., 112, 121, 125, 156, 184, 197, 201 ff., 227 ff., 397, 403; II: 8, 169, 189, 210, 221, 271 ff., 279, 303, 309, 343, 348, 353 ff., 383, 387 ff., 408, 441, 446, 449 ff., 455 ff., 464 ff., 470, 513, 515 ff., 521 ff., 530 ff, 541 ff., 550, 554, 557 ff., 559, 570, 605 ff.
Jarkent-darjaning-koschluschi. Con. The Confluence of Jarkent-darja. II: 513.
Jarkent-darjaning-kujluschi or -kujluschi. Con. I: 78, 79.
Jar-kotan. Fo. tr. The Terrace Hut. I: 55 ff., 72; II: 558, 589.
Jar-kuduk. Vil. The Terrace Well. I: 36.
Jar-kum. Dist & Sd. dn. The Terrace Sand. I: 123, 127; II: 537.
Jar-tongus. Smt. The Boar Terrace. I: 375, 380.
Jar-tongus-terem. Smt. The River of the Boar Terrace. I: 380.
Jartu-puka-tscheke. II: 513.
Jaruk. Str. rg. The Terraces. I: 224; II: 216.
Jaschanglik-köl. La. I: 433.
Jäschil-kol. La. The Green Lake. I: 433.
Jas-julghun. Os. The Summer Tamarisk. II: 600, 604.
Jaslak. Fo. tr. The Summer Place. I: 387.
Jäti-arali. La. The Seven Men. II: 104.
Jäti-davan. Dist. The Seven Passes. II: 77.
Jati-germe. Str. rg. The Seven Earth Grottoes. I: 80.
Jati-jaghatsch. Fo. tr. The Seven Trees. II: 10.
Jatim-kirlidi. Fo. tr. I: 48.
Jätim-tarim. Riv. The Fatherless and Motherless River. I: 192 ff., 202 ff., 419 ff., 424, 485 ff., 497, 500 ff., 508 ff.; II: 335, 343, 505, 509 ff., 548, 559, 561, 596.
Jätim-tschapghan. Ca. The Lonely Canal. II: 510.
Jätin-bulak. Sp. The Solitary Spring, because it is situated at some distance from other springs in that tract. II: 77, 80.
Jäti-schahr. Prov. The Seven Towns. I: 383; II: 605.
Java Muhamed-basch-köl. La. The Upper Lake of the Wild Muhamed. II: 512.
Jegrenlik-kir. La. The Roe-deer Mud. II: 194, 211.
Jegren-sulak. Dist. The Roe-deer's Drinking-Place. I: 425.
Jek-schamba-basar. Vil. The Monday Bazar. I: 7.
Jemischek. Riv. a. A measure for weighing grain in. I: 419 ff., 487, 490, 497.
Jemischek-kok-ala. Riv. The river-arm of the ? I: 419, 424, 487, 490; II: 335.
Jemischek-kok-alasi. Riv. I: 192, 193, 204; II: 559.
Jempen. St. The Wall. II: 583.
Jen-tso. The Salt Marsh. II: 349.
Jeren-patti. Fld. Where the Roe-deer Sank. I: 17.
Jeschil-kol. La. The Green Lake. I: 102.
Jesi-kol. Fo. tr. The Shallow Lake. I: 74 ff., 80; II: 559, 589.
Jesi-kol. La. II: 534, 554.
Jigde-basch-tscheke. Ho. The Head Promontory of the Eleagnus. II: 513.
Jigde-bulak. Sp. The Eleagnus Spring. I: 509.
Jigde-bulak. Sp. II: 52 ff.
Jigde-gerem. Fo. tr. The Eleagnus Hut. I: 62.
Jigde-jasuk. Fo. tr. The Eleagnus Lagoon. I: 30.

Jigde-kotan. Fo. tr. The Eleagnus Hut. I: 63. 73; II: 534.
Jigde-ortang. Fo. tr. The Eleagnus Station. I: 39. 50, 65.
Jigdelik. Fo. tr. The Eleagnus Place. I: 52. 430; II: 532, 554. 560. 580.
Jigdelik-aghil. Fo. tr. The Eleagnus Camp. I: 307. 308.
Jigdelik-akin. Ca. The Stream with the Eleagnus. I: 110.
Jigdelik-kol. La. The Eleagnus Lake. I: 116.
Jigde-ostang. Ca. The Eleagnus Canal. II: 580.
Jigde-sore. Fo. tr. The Eleagnus Hut. I: 146.
Jigde-sorening-koli. La. The Lake of the Eleagnus Hut. I: 146.
Jigde-soru. Fo. tr. The Eleagnus Hut. I: 118.
Jigde-tegisch. Fo. tr. Plenty of Eleagnus. I: 106 ff.
Jigde-togh. Dm. The Eleagnus Dam. I: 67.
Jigde-tschakil. Fo. tr. The Eleagnus River-Loop. I: 104.
Jildislik. Vil. The Root Place. I: 9.
Jildis-toghrak. Fo. tr. & Ho. The Poplar-Root. I: 83.
Jileg-uj. Sd. hl. The House of the Jileg-berries. I: 185.
Jilgha Riv. The Valley. I: 99 ff.; II: 535.
Jilgha-kol. Po. The Narrow Lake. I: 101; II: 509.
Jilik-otak. Str. rg. The Dwelling-Place all the Year round. I: 219.
Jimbel-toghrak. Fo. tr. j = an instrument very like a sieve for baking pilmen. I: 103.
Jim-pen. Old Tn. The Wall. II: 34. 583.
Jing-pang. Fo. tr. & ho. Chinese: the Wall. I: 75.
Jing-pen. St. The Fortress. I: 427; II: 11, 15. 30 ff., 40 ff., 52, 63 ff., 76. 90 ff., 225, 571, 582, 583.
Jirim. Rg. Frontier: marked by a line of "nischans" or tokens, poles; jirim is also the thick pole which supports the roof of a kamish hut. I: 423. 427, 502.
Jirinde. St. Where Dry Wood is Chopped to Pieces. I: 58, 67.
Jirintschi. Vil. I: 67.
Jo-bulak. Sp. The Lhasa Spring. II: 472.
Jodak-köl. La. II: 194.
Jokanak-kol. La. The Sedge Lake. II: 143.
Jokarki-arelisch. Con. The Upper Confluence. I: 137.
Jokarki-jardang-bulak. Sp. The Upper Terrace Spring. II: 54.
Jokscho-kol. La. The Breeding Lake. I: 507.
Jol-aghsi. Rg. with rd. The Beginning of the Road. I: 88.
Jol-arelisch. Tr. Where the Road Divides. II: 218, 293.
Jolbars-äsildi. Fo. tr. Where the Tiger was killed. I: 73.
Jolbars-baschi. Fo. tr. The Tiger's Head. I: 104.
Jolbars-baschi. II: 513.
Jolbars-kotan. Fo. tr. The Tiger Hut. I: 18.
Joldachte-uj. Des. ho. The Comrad's House. I: 183.
Jolsis-kakmasi. Bay. The Cul-de-sac Bay. I: 251. 276.
Jol-tschapghan. Ca. The Road Canal. II: 152, 156, 595.
Judaktane-kok-alasi. Riv. a. Judakta's River-arm. I: 503. II: 561.
Jugen-taravaldi-tscheke. Riv. lo. II: 505.
Jughan-balik. La. The Big Fish. I: 40 ff., 103; II: 303, 554, 560. 589.
Jughan-balik-kol. La. The Lake of the Big Fish. I: 40 ff.; II: 531.
Jughan-balik-tallik. Fo. tr. The Forest of the Big Fish. I: 41.
Jughan-kum. Sd. The Big Sand. I: 380.
Jughan-tapup-aldi. Str. rg. Where the Bridle was Found. I: 102.
Jughas-basch-bulung. Fo. tr. I: 75.
Ju-jing-pen. St. ho. II: 33 ff., 582. 583.
Ju-min. Vl. II: 373, 374.
Ju min-sian. Tn. II: 371.
Jul-annam. Mt. A name. k 40. 41.
Juldus. Vl. The Star. II: 98, 300.
Juldus-bagh. Vil. The Star Garden. I: 89.
Julghun-bulak. Sp. The Tamarisk Spring. II: 78.
Julghun-kol. La. The Tamarisk Lake. I: 94.
Julghunlik-kol. Old la. The Tamarisk Lake. I: 403, 414, 433.
Julghunlik-köl-kuduk. Wl. The Well of the Tamarisk Lake I: 404.
Julghunluk-köl. La. The Tamarisk Lake. I: 221.
Julghunluk-kol. La. I: 435.
Julghunluk-terem. Riv. a. The Tamarisk River. II: 504.
Julghun-tuse. Os. The Plain of the Tamarisks. II: 38, 87.
Jumalak-darja. Riv. The Round River. I: 113, 115. 121. 137 ff.; II: 302. 537.
Jumulak-tagh. Mt. The Round, i. e. cupola-shaped, Mountain. II: 88, 89.
Junus-ottogho. Pl. J's Dwelling-Place. I: 179.
Jupoga. Dist. & vil. I: 7, 8, 9; II: 601, 602.
Jurkelik-tscheke. Fo. tr. j. is a parasitic plant growing amongst the kamish. I: 145.
Jurt-tschapghan. Vil. The Village Canal. I: 174, 215. 224. 437. 439. 444. 454, 457, 497; II: 131 ff., 151 ff., 155 ff., 159 ff., 192, 204 ff., 213 ff., 218, 275. 283. 516, 560, 592 ff., 595 ff., 601.
Jurt-tschapghan. Dist. II: 153.
Jurun-kasch. Riv. The Piece of (?) Yade Stone. II: 300. 523. 525 ff., 604 ff., 611.
Jussup-baj-satmasi. Ht. J. B's Hut. I: 308.
Jussup-Bekning-toghi. Dm. J. Bek's Dam. I: 64. 65.

Kade-dung. Dn. The Pole Hill. I: 52.
Kade-dung. Sd. dn. I: 92.
Kade-dung. Hl. I: 106; II: 555. 570. 589.
Kader Bajning-ujdake-tscheke. Ho. The Promontory of K. Baj's House. II: 513.
Kade-tiklaghan-dung. Hl. The Hill where a Pole was Put up. II: 217.
Kadike. Vil. The Great Open Place. I: 403. 404. 407, 498; II 596, 604.
Kadike-ilek. Riv. a. The River of the Open Place. I: 403.
Kaghdan. Fo. tr. A Field of kamish, to which the water does not reach at high-water. I: 87.

Kaghune-kakmasi. Bay. The Melon Bay. I: 255, 278, 280 ff.
Kaghune-kolu. La. The Melon Lake. I: 168.
Kair-kotan. Ht. The Alluvial Hut. I: 159.
Kajgulla. Vil. I: 7.
Kajlur. Vil. I: 100.
Kajul-köi. La. II: 152
Kakde. Vil. The Silty; kakde is also the leaves of young poplars given to sheep. I: 115 ff., 118; II: 555, 590.
Kakde-darja. Riv. bd. The Silty River. I: 113, 114.
Kaken-dijni-dschaji. La. The Grave of K. Dij. I: 187, 188.
Kakmak-tschantschdi. La. Caught in the Spring-trap; because a man happened to walk into such an instrument. II: 211.
Kakmak-tschatschkan-köl. La. II: 143.
Kakmar. Bay. The Deep Bay. I: 255.
Kakschal. Fo. tr. The Dry Tree. I: 16.
Kakschallik. Fo. tr. A Place with a number of Tamarisks, or generally where trees and dry trunks are abundant. I: 14.
Kak-su. Sp. The Silty Water; ordinarily a temporary little lake, former by a rain-water torrent, which is generally laden with silt and mud. II: 62, 77.
Kala-askan. Fo. tr. The Susgended Skull. I: 149.
Kala-dung. Fo. tr. The Skull Hill. I: 47; II: 532.
Kalaghatsch-jalangi. Str. rg. The Open Place with a Skull on a Pole. I: 80.
Kalaghatsch-kujlusch. Con. The Confluence of the Pole with a Suspended Skull. I: 65.
Kala-kujdi. Fo. tr. The Burnt Lizard. I: 390.
Kälälik. Fo. tr. and st. The Place of Lizard. I: 105.
Kala-ölgän-kum. Vil. and Sd. The Desert where the Cow Died. I: 116.
Kala-ölgän-uj. Vil. The House of the Dead Cow. I: 118.
Kala-sugha-jaghilghan-jer. Dist. The Place where the Cow fell into the Water. II: 511.
Kala-sulägä. Fo. tr. The Cow's Drinking-Place. I: 61.
Kalingning-dschaji. Fo. tr. The Grave of Kaling. I: 18.
Kalka. Vl. II: 392, 393.
Kallap-tagh. Mt. I: 41, 65.
Kallaste. Wl. Where the Skull was Hung up. I: 370, 390.
Kalmak-jilghasi. Fo. tr. The Mongolians' Valley. I: 14.
Kalmak-kum. Sd. dn. The Mongol Dunes. I: 61, 69; II: 533, 554, 558, 589.
Kalmak-ottogho. Riv. Where the Mongol Dwelt. I: 181, 220, 506 ff., 510; II: 548, 561, 594, 596.
Kalmak-tuschdi. Fo. tr. Where the Mongol Encamped. II: 10.
Kalmak-tuschken-dung. Hl. The Hill of the Camping Mongols; as Mongol Lhasa pilgrims are said to have camped here. I: 429.
Kalmak-uldi. Rg. Where the Mongol Died. II: 94.
Kalpin. Vil. I: 53.
Kälpin-satmasi. Ht. I: 65.
Kalpuk-utschugho. Fo. tr. The Fireplace of K. (u. = a hole in the ground for the fire, over which the kasan or pot is placed upon an iron or three stones). II: 10.
Kalta. Vil. Short. II: 11, 15, 571.
Kalta-bel. Fo. tr. The Short Passage. I: 105.
Kalta-jajlak. Vil. The Short Pasturage. I: 7.
Kaltaning-basch-toghraghi. Fo. tr. The Upper Poplars of Kalta. II: 14.
Kalta-natschuk. Vil. Little N. I: 4; II: 604.
Kalta-schipang. Riv. The Little Steppe. I: 386.
Kalta-tokaj. Dist. The Little Forest. I: 200.
Kaltschini-bajiri. Ba. Kaltschi's Depression Lake. I: 228, 229.
Kaltschi-tokkan. Fo. tr. Where K. Begat a Child. I: 429.
Kalughutsch. Con. An insect found in houses. I: 54.
Kamaghas. Wl. Kamar = otter; ghas = goose. I: 376, 381.
Kamar-darjasi. Riv. br. The Otter River. I: 94.
Kamber Schang-janing-jokarki-jangi-arighi. Ca. The Upper New Canal of K. Bek. I: 124.
Kamber Schang-janing-jokarki-totter-suji. Ri. The Upper Lost Water of K. Bek. I: 123.
Kamschuk-ottogho. Bol. Where the Kamschuks Halted. I: 210.
Kamschuk-tüschken-toghrak. Fo. tr. The Poplar where the Kamschuks Encamped. I: 185.
Kamuschluk-bulak. Sp. The Reed Spring. II: 471.
Kamuschluk-köli. La. The Lake of the Reeds. II: 152.
Kan-arik. Ca. The Royal Canal. I: 6 ff., 10.
Kan-arik. Vil. I: 7; II: 600, 601, 604, 605.
Kanat-baghlaghan-kol. La. The Lake of the Bound Wing. II: 125, 144, 149.
Kan-begi. Fo. tr. The Royal Bek. I: 84 ff.; II: 554, 589.
Kandi-arik. Ca. The Royal Canal. I: 126.
Kan-joli. Rd. King's Road. I: 431.
Kan-kiang. II: 443.
Kanscha-jantak. Dist. Where the Alhagi begins to Show. I: 370.
Kanscha-kum. Fo. tr. and Sd. dn. The Beginning of the Sand. I: 27; II: 530.
Kan-su. Prov. II: 380, 395, 441, 443, 448.
Kant-bulak. Ld. mi. The Sugar Spring. II: 87.
Kan-tengri. Pk. II: 97.
Kan-tja. II: 395.
Kan-toghi. Sd. and tms. The King's Dam. I: 159.
Kan-toghrighi. Fo. tr. and ma. The King's Poplar. I: 72.
Kan-toghu. Dm. The King's Dam. I: 502.
Kantschik-oldi. Dist. Where the Kantschik died I: 94.
Kan-tschou. Tn. II: 395.
Kapa. Gd. mi. The Stone Hut. I: 370 ff.
Kapa. Fo. tr. The Stone Hut? I: 48.
Kapkaktschi. Fo. tr. The Spring-trap-maker. I: 75.
Kaplämä-kum. Sd. dn. I: 69.
Kaptar-asti. Fo. tr. The Suspended Pigeon. I: 58; II: 589.
Kaptschal-bulak. Sp. The Spring where Torrents come down after Rain. II: 77.

Kara-aghis. Rvn. The Black Mouth. II: 55.
Kara-akin. Riv. The Black Stream. I: 110 ff., 119 ff., 124: II: 537. 569.
Kara-akin-kojuschi. Con. The Confluence of the Black Stream. I: 123.
Kara-basch-salghan. La. Where the Black Head was put: or: the Settlement of K. B. I: 433.
Kara Bourân. La. The Black Storm. II: 310. 311.
Kara-buka. Rg. The Black He-Yak. I: 52. 65.
Kara-buran. La. The Black Storm. I: 215. 221. 223. 351. 392. 398 ff.. 449. 456. 510; II: 120. 169, 184. 198 ff.. 204. 212, 216, 250. 261 ff., 272, 275. 279. 296. 301. 307 ff.. 310, 312, 333. 348, 357 ff.. 362. 425. 467. 504, 515. 526. 545. 548. 551.
Kara-daj. Str. rg. The Young Black Goose. I: 192.
Kara-daj. Sd. I: 424.
Kara-daj. Pl. I: 498.
Kara-daj-ortang. St. The Canal of the Young Black Goose. II: 505.
Kara-dasch. Fo. tr. The Black Salt Pool. I: 100.
Kara-daschi. Fo. tr. The Black Lake. I: 98; II: 555, 589.
Kara-daschi. Fo. tr. II: 470.
Kara-dung. Ru. The Black Hill. I: 79; II: 174.
Kara-dung. Lp. I: 83.
Kara-dung. Hl. I· 159.
Kara-dung. Hl. I: 430.
Kara-dung. Vil. I: 431.
Kara-dung. Pl. II: 505.
Kara-ghatik. Po. A Plant. I: 213.
Kara-ghatik-jarsighi. Dist. The Lagoon of k. g. I: 213.
Kara-ghatik-köl. La. The Lake of k. g. II: 10.
Kara-gudschek. Fo. tr. The Black Oar. I: 65.
Kara-jilgha-darja. Riv. br. The River of the Black Valley. I: 51. 54 ff.. 64 ff.: II: 532.
Kara-kan-patschim. Ma. Our Father of the Black Blood. I: 6.
Kara-kasch. Riv. The Black Jade. II: 272, 523. 525 ff.
Kara-kasch. Tn. II: 604. 605. 611. 614.
Kara-kertschin. Riv. bd. The Little Black Forest. I: 85. 89; II: 534.
Kara-khodscho. Trb. II: 276. 299.
Kara-kija. The Road on the Black Hills (Tract on the Lower Tschertschen-darja: not in the Text.)
Kara-kir. Sd. The Black Mud. I: 435.
Kara-kirtschin. Vil. The Little Black Forest. I: 67.
Kara-kirtschin. Fo. tr. II: 470.
Kara-kisil. Mt. ra. The Deep Red. II: 86.
Kara-kisil-tuse. Vl. The Plain of the Deep Red. II: 86.
Kara Kochoun. La. II: 310. 311.
Kara-ködschäk. Fo. tr. The Black Oar. I: 83; II: 569.
Kara-kol. Rg. The Black Lake. I: 67: II: 135.
Kara-kol. La. I: 188, 207, 215. 304. 414. 416. 424. 451. 454. 457. 472. 474, 484 ff.. 496; II: 70. 135. 210, 215, 222. 227, 276, 298. 304 ff., 311 ff., 330 ff., 341 ff., 354. 356 ff.. 363. 518. 548. 561. 580, 581.
Kara-köldeki-satmasi. Des. sa. The Hut of the Black Lake. I: 488.
Kara-korum. Mts. The Black Stony Place. Pass. I: 78.
Kara-koschun. La. The Black Salt Lake. I: 11, 79. 107. 182, 184, 188. 204. 222. 224, 258. 260. 265. 268 ff.. 287. 292, 294, 300, 305. 308, 326. 350, 384, 392. 406. 433. 437. 440 ff.. 449 ff.. 456 ff. 463 ff., 468 ff., 474. 480 ff, 497 ff., 508 ff.; II: 64. 70 ff.. 83 ff.. 89. 96. 104 ff., 114 ff., 125 ff., 151 ff., 181 ff., 187 ff., 200 ff.. 215 ff., 221 ff.. 234 ff., 257 ff., 266 ff., 283, 287 ff., 300 ff., 333 ff., 349. 352 ff.. 376. 379. 388. 441. 446. 451, 458, 465. 469. 471, 483. 489. 515. 517 ff., 548 ff.. 560 f.. 577 ff.. 584, 588, 591, 592. 593. 594. 595 f., 608, 620.
Kara-koschun. Vil. Koschun is also said to mean a place where cattle are driven together for grazing; pasturage. I: 441; II: 179.
Kara-koschun-kol. La. II: 140 ff.
Kara-koschun-kul. La. II: 271 ff.. 277 ff.
Kara Koshun. La. II: 97, 306 ff.
Kara-kotchun. La. II: 268.
Kara koul. La. The Black Lake. II: 310.
Karaksil. Mt. ra. The Deep Red. II: 86.
Kara-kul. La. The Black Lake. II: 265. 276. 299. 522.
Kara-kum. Vil. The Black Sand. I: 427. 429, 508; II: 5. 604.
Kara-kum. Dst. II: 68, 396, 405, 415; 440. 444 ff., 449.
Kara-kum-kuduk. Wl. The Well of the Black Sand. I: 9.
Kara-kurchin. La. II: 262.
Kara-kurtschin. Abandoned Vil. I: 441: II: 133. 179.
Kara-kurutsch-aghil. Stp. The Fold of the Black Lamb. I: 383.
Káralik. La The Place of Lizards. I: 432.
Káralik. Fo. tr. II: 6.
Kara-muran. Riv. The Black River. I: 329. 340. 373 ff.; II: 221. 348. 522 ff., 525.
Karani-kadasi. La. The Poles Put down; where some poles were driven into the bottom of a canal, to fasten the nets on. I: 433.
Kara-nur. La. The Black Lake. II: 277. 278.
Kara-otschke-ölturghan. Str. rg. Where the Black Goat was Killed. I: 379.
Kara-saj. Riv. bd. The Black Valley. I: 40. 50. 52.
Kara-saj. Vl. I: 370.
Kara-satma. Ho. The Black Hut. I: 110.
Kara-schahr. Tn. The Black Town. II: 35. 38, 85, 87, 99, 174. 271. 300. 307. 399. 600. 611, 614.
Karaschar. Tn. II: 287.
Kara-schipang. Fo. tr. The Black Steppe. II: 217.
Kara-tal. Str. rg. The Black Willow. I: 80. 83.
Kara-tisme. Fo. tr. (jaghatschdan tisip = made of wood); a Black Built Hut. I: 62, 65.
Kara-toghrak. Fo. tr. The Black Poplar. I: 72, 88.
Kara-toghrakning-kemisi. Fo. tr. The Canoe of the Black Poplar. I: 88.
Kara-tokaj. Fo. tr. The Black Forest. I: 16, 39.
Kara-tschatsch. Ho. The Black Pole. I: 168, 425.

Kara-tschatsch. Riv. br. I: 431, 436: II: 505.
Kara-tschege-köl. Old la. The Lake of the Black Asclepias. I: 183.
Kara-tschilan. Vil. Name of a water-fowl that lives on fish. I: 115.
Kara-tschilandake-togh. Dm. The Dam of the Black Serpent (?). II: 510.
Kara-tschumak. Vil. The Black Cap. I: 118.
Karaul. Vil. The Watch-House. I: 115 ff., 120, 128, 130, 140, 151, 169 ff., 227, 298, 305, 333, 461; II: 205, 302, 335, 356, 446, 449, 451, 458 ff., 540, 545 ff., 559, 571, 574 f., 590.
Karaul. Dist. I: 146, 149 ff., 155, 157, 159; II: 275.
Karaul-dung. Fo tr. The Watch Hill. I: 24 ff.; II: 530.
Karaul-dung. Sd. dn. Watch-Hill. I: 111.
Karaul-dung. Hl. I: 118.
Karaul-dung. Sd. I: 151.
Karaul-dung. Hl. The Watch Hill. I: 308.
Karaul-dung. Hl. II: 217.
Karaul-kol. La. The Watch Lake. II: 152.
Karaul-mähallä. Vil. The Village with the Watch-House. I: 118.
Karaulning-ujdake-tscheke. Vil. The Promontory of the Watch-House. II: 513.
Karaune. Str. rg. The Black Goose. I: 192.
Karaune. Rg. I: 423.
Karaune-kol. Po. I: 89.
Karaunelik. La. The Place of the Black Geese. II: 335.
Karaunelik-kol. La. The Lake of the Black Geese. I: 147.
Karaunelik-kol. La. I: 166, 168.
Karaunelik-kol. La. I: 252 ff., 257 ff., 275 ff., 280 ff., 296, 298 ff., 304 ff., 319; II: 344.
Karaunelik-kol. La. I: 433, 434, 436
Karaunelik-kol. La. I: 450 ff., 453 ff, 457 ff, 460 ff., 487, 497; II: 130, 505, 509, 550, 596.
Karaunelik-tokkan-kol. La. The Lake where the Black Goose breeds. II: 509.
Karaune-tokkan-dschajir. La. The little Lake where the Black Goose breeds. I: 482.
Karaune-tokkan-ilek. Riv. br. The River Arm where the Black Goose breeds. I: 483.
Karaune-tokkan-kol. La. The Lake where the Black Goose breeds. I: 111.
Karaune-tokkan-köl. La. I: 208, 287.
Karaune-tokkan-köl. La. I: 297, 299.
Karaune-tokkan-köl. La. I: 470 ff.
Karaune-tokkan-kol. La. II: 505, 509.
Karaune-tokkan-kol. La. II: 512.
Karaune-tokkanlik-köl. La. The Lake where the Black Geese are used to breed. II: 512.
Karaune-tokkan-toghrak. Fo. tr. The Poplar in which the Black Goose lays its Eggs. I: 483.
Karaune-tschekesi. Riv. lo. The Promontory of the Black Goose. II: 505.
Kargha-asti. Str. rg. The Suspended Raven. I: 504, 505.
Kargha-jakti. Fo. tr. The Raven put Fire (to the kamish; Kargha here probably a man's name). I: 126; II: 555, 590.
Kargha-lampasi. Rg. The Raven Hut. I: 65.
Karghalik. Tn. The Raven's Town. II: 367, 466, 601, 605, 610.
Karghalik-otak. Str. rg. The Place of the Ravens. I: 215; II: 503.
Karghasi asti. Str. rg. The Suspended Raven. I: 150.
Kärki-tschokken-kol. La. The Lake where K. was Drowned. II: 513.
Karlik-tagh. Mt. The Snowy Mountain. II: 102.
Kartschigha-dschaji. Dist. The Little Falcon's District. I: 94.
Kas. La. See Ghas. II: 278.
Kasak. Vil. The Kasak (a Kirgiz tribe). I: 99.
Kasak-jajlaki. Fo. tr. The Kasak's Summer Dwelling. I: 99.
Kasan-asma. Fo. tr. Do not hang up the Pot; (because there is no fire-wood). I: 83.
Kasan-bulak. Sp. The Pot Spring. II: 77.
Kasan-kati. La. The Pot Disappeared. I: 498.
Kasan-käti-kol. La. The Lake of the Lost Pot. I: 493, 498.
Kasan-sindi. Old lp. The Broken Pot. I: 205.
Kasan-sindi. Fo. tr. II: 11.
Kaschgar. Tn. I: 3, 7, 10, 40, 230, 369; II: 133, 353, 381, 395, 487, 533, 565 ff., 568 ff., 571, 582, 605, 611 ff.
Kaschgar-darja. Riv. I: 36, 38, 40, 51, 58 ff., 63 ff., 66 ff., 73, 100; II: 348, 354, 408, 517, 522 ff., 531 ff., 534, 566, 570, 606.
Kaschgaria. Prov. II: 387, 388, 612 ff.
Kasch-kotan. Fo. tr. The Jade Hut. I: 99.
Kasch-kum. Sd. dn. The Jade Sand. I: 69.
Kasch-otak. Rg. The Terrace Dwelling-Place. II: 586.
Kaser Eisa Achun-tschapgan. Ca. The Canal of K. E. A. I: 174.
Kashgaria. Prov. II: 270.
Kasi-kalaning-kona-koligi. Old la. The Old Lake of K. Kala. II: 505.
Kasi-kalaning-tschapghandaki-kona-satmasi. Old ho. The Old Hut of K. K's Canal. II: 509.
Kasim-tschapghan. Ca. K's Canal. I: 505.
Kasi-nor. La. See Ghas. II: 278.
Kasuk-akti. Fo. tr. The Tent Peg that is Driven down or Tethering-peg. II: 10.
Katar-julghun. Os. The Tamarisk standing on one Line. II: 77, 83.
Katik-arik. Ca. The Hard Canal; because the canal is situated in hard clay-ground, where it is difficult to work with the spade. I: 180, 182 ff., 287 ff., 296 ff., 505.
Katik-arik-tschekesi. The Promontory of the Hard Canal II: 505.
Kätschik. Fo. tr. The Ford. I: 116 ff., 126, 160, 224, 391; II: 555, 590.
Katschip-ulturghan. Fo. tr. Where the Run-away was Killed. II: 10.
Katschkan-uj. Fo. tr. The Run-aways' House or The Abandoned House. II: 10.
Katschkene-dschajiri. Ho. The Run-aways' Little Lake. I: 168.
Katschkene-jarsighi. Str. rg. The Run-aways' Lagoon. I: 192.

Katschkin-aghis. Sd. I: 121; II: 555, 590.
Katschung. Vil. II: 604.
Kattar-scholgun. Sp. The Big Tamarisk. II: 80.
Kau tja-shien. II: 395.
Kavak-asti. Str. rg. The Suspended Water-Vessel. I: 210.
Kelvetschuk-darja. Riv. I: 4.
Kemi-salagä. Pl. Where the Canoes are put into the Lake. I: 65.
Kemi-salik. Str. rg. Where the Canoes are put into the Lake. I: 502.
Kemi-tapdi. La. The Found Canoe. I: 402.
Kemi-tschapghan-köl. La. The Lake where Canoes are Cut. II: 510.
Kemi-tschapti. Fo. tr. Where the Canoe was Hollowed out. I: 103.
Keng-lajka. Dist. The Broad Clay Region. I: 312, 348, 351, 354, 369, 383, 385, 410; II: 571, 572.
Keng-lajka. Al. tr. I: 397 ff.
Kengrak. Rg. I: 67.
Kengrak-ortäng. Pl. I: 51.
Kenija. Fo. tr. I: 27.
Kepek-uj. Des. vil. The Bran House. I: 181, 194; II: 594, 596.
Kepek-uji. Pl. I: 512.
Kéria. Tn. II: 311, 613.
Kéria daria. Riv. II: 309.
Kerija. Dst. I: 293; II: 221, 525.
Kerija. Tn. I: 370, 375; II: 282, 286, 293 ff., 382, 526 ff., 570, 605, 611.
Kerija. Os. II: 350, 525.
Kerija-darja. Riv. I: 16, 71, 79, 92, 98, 115, 144, 243, 247, 293, 302 ff., 318, 328 ff., 363 ff., 378 ff., 411, 414; II: 174, 221, 258, 282, 309, 348 ff., 367, 370, 387, 405, 449, 458 ff., 463, 466, 487, 521 ff., 534, 565, 567, 571 ff., 606.
Kerije-tokaj. Fo. tr. The Thick Young Forest. I: 16.
Kertme. Wl. I: 371.
Kerulen. Riv. II: 381.
Kesgen-tarim. The Cut off River. II: 505.
Kesken-toghrak. The Cut off Poplar. II: 503.
Ketme. Wl. I: 371.
Ketme-kuduk. Wl. I: 371; II: 309.
Ketmen-kaldi. Str. rg. Where the Spade was Left. I: 214.
Kettek-schaari-kum. Dst. The Desert of the Town Kettek. I: 227.
Khadatu. St. II: 285.
Khaidu-gol. Riv. II: 300.
Khara-nur. La. The Black Lake. II: 278, 290.
Khas. La. See Ghas. II: 295.
Khas-nor. La. II: 279, 281 ff.
Khas-nur. La. II: 277 ff., 285 ff., 292, 294 ff.
Khas-omo. La. II: 260 ff., 267 ff., 278 ff., 295.
Khotan. Tn. I: 79, 378; II: 309, 367, 611 ff.
Khotan-darya. Riv. II: 272.
Khoya Suga-bulak. Sp. See Chodsche-Schukur-bulak. II: 472.
Khuduk-ussu. Wl. The Well Water. II: 291.
Khu-Li. Ctry. II: 300.
Khulu-sutai. St. The Reedy Place. II: 278.
Khu-pu. St. II: 278, 286.
Kijak-kol. La. The Reed Lake. I: 110.
Kijik-talning-baschi. Ho. I: 389.
Kijik-tele-tschol. Fo. tr. The Pool of Willows where Antelopes are Abundant. I: 27; II: 530, 554, 558, 588.
Kimur-chani. Dist. II: 94, 96, 390.
Kirghuj Pavan-jaghatsch-tscheken-bolto. Sou. The Sound where K. P. carried Wood. I: 480.
Kirghuj Pavan-tagirmän-kok-alasi. Chl. The River-arm with K. P's Mill. I: 506.
Kirgis-Hakimi-lenger. St. The Station of the Kirgiz Doctor. I: 67.
Kirgis-nor. La. The Kirgiz Lake. II: 381.
Kirisch. St. The Bowstring. I: 67.
Kirk-kischlak. Str. rg. Forty Camps. I: 51.
Kirk-saj. Rg. Forty Valleys. I: 373; II: 521 ff., 527 ff.
Kirtschin. Ca. K. = brushwood and dry branches for inclosing sheepfolds. I: 176 ff., 203, 260, 286, 429, 499, 508; II: 556, 559.
Kirtschin-darja. Riv. The River of the Branches; or of the Little Forest-tract. I: 406.
Kirtschin-kol. La. The Lake of the Little Forest. II: 194.
Kirtschin-kotan. Dist. The Hut of Branches. I: 427, 502.
Kirtschinlik-kol. La. The Lake of the Little Forest. II: 211.
Kirtschin-tarim. Part of Tarim. II: 592, 596.
Kischlak-aghil. Stp. The Shepherd's Winter Camp. I: 383.
Kischlak-uj. Ht. The Winter Dwelling. I: 147; II: 556, 569.
Kisil-boje. Riv. A Plant. I: 6.
Kisil-boje-darja. Riv. I: 5.
Kisil-igis-tagh. Mt. The Red High Mountain. II: 88.
Kisil-kum. Sd. The Red Sand. I: 83, 87 ff., 91, 94; II: 396, 444 ff., 449, 451, 534 ff.
Kisil-sangir. Vil. and St. II: 92 ff.
Kisil-sangir-tagh. Mt. ch. The Mountain of the Red Heel. II: 26, 93 ff.
Kisil-sepetsch. Fo. tr. The Red Cap. I: 18.
Kisil-sinir. Vil. Red Heel. II: 4, 38, 87 ff., 92.
Kisil-su. Riv. The Red Water; i. e. Salt Water in contradistinction to Ak-su or Kara-su, which is Fresh Water. I: 3 ff.
Kisil-su. Po. I: 425.
Kisil-su. Old. bol. I: 499.
Kisil-su. Riv. II: 533.
Kisil-tagh. Mt. The Red Mountain. II: 38, 86.
Kislar-sarati. Ma. The Maidens' Burial-place. I: 52.
Kitaj-chat-kaldi. Fo. tr. Where the Chinaman wrote a Letter. I: 429.
Kitaj-kobruk. Br. The Chinese Bridge. II: 6.
Kitjik-altin-tag. Mt. The Little Gold Mountain. II: 93.
Kitschik Aghetschadake-kum-tscheke. Fo. tr. The Sandy Promontory of the Little Aghetscha. II: 513.
Kitschik-atscha. Riv. The Little Mouth. I: 224.
Kitschik-hasanak. Riv. I: 110; II: 555, 590.
Kitschik-ogen. Riv. Little Ogen. I: 110, 111, 113, 119.

Kobruk. The Bridge. II: 78.
Kobsak. Dist. Where a River is Divided into many Arms. I: 97.
Kobsak-darjasi. Riv. The Dividing River. I: 97.
Kodaj-darja. Riv. The Swan River. I: 34, 36 ff., 47, 49, 51, 53 ff., 63 ff., 69; II: 303, 531.
Kodajlik. Fo. tr. The Swan Place. I: 72.
Kodajlik-kol. La. The Swan Lake. II: 512.
Kodake-kojghan Str. rg. I: 207.
Koghune-mudschuk. Cp. The Melon Cape. I: 281.
Koghunluk. Fo. tr. The Place of Melons. I: 87; II: 534.
Koghunlukning-toghraghi. Fo. tr. The Poplar of the Melon Place. I: 87.
Koj-baschi. Fo. tr. The Sheep's Head. I: 92.
Koj-salghan-togh. The Dam where Sheep are put over. II: 510.
Koj-tutuni. Stm. Where the Sheep was caught. I: 509.
Koj-tutuni-kok-alasi. Chl. The River-arm of the Caught Sheep. I: 506.
Kok-ajak. Fo. tr. The Green Foot. I: 73.
Kòk-akin. Fo. tr. The Blue Stream. I: 73.
Kok-ala. Riv. The River-Branch. I: 419 ff., 424 ff.
Kok-ala. Riv. I: 429 ff.
Kok-ala. Riv. a. I: 436.
Kok-ala. Riv. br. I: 479 ff., 487; II: 596.
Kok-ala. Riv. a. II: 504.
Kok-aladake-kotan. Ht. The Hut of the River-Branch. I: 420.
Kok-ala-kol. La. The Lake of the River-Branch. I: 160, 220.
Kok-angis. Dist. (Angis is an abandoned, formerly cultivated field); thus the Green Field. I: 425.
Kok-burun. Vil. The Green Promontory. I: 100.
Kok-jantak. Ht. The Green Alhagi. I: 381.
Kok-kapa. Ht. I: 381.
Kok-kol. Fo. tr. The Blue Lake. I: 18.
Kok-kol. Fo. tr. & la. I: 105 ff.
Kok-kol. La. I: 184.
Kok-köl. La. I: 287.
Kok-kol. La. I: 297, 299.
Kok-köl. La. II: 511.
Kok-kol-atschal. Mth. The Mouth of the Blue Lake. I: 106.
Kok-kolning-akini. Ca. The Channel of the Blue Lake. I: 106.
Kok-schal. Mt. II: 97.
Kok-su. Dist. The Blue Water. II: 90.
Kok-toghrak. Fo. tr. The Green Poplar. I: 62.
Kok-toghrak. Fo. tr. I: 468.
Kok-toghrak. Fo. tr. I: 482.
Kok-toghrak. Id with Fst. I: 493.
Kok-tschol. Vil. The Blue Little Lake. I: 50.
Kok-tschol. Chl. I: 102.
Kok-tschol. Fo. tr. I: 104; II: 589.
Kok-tschol. Ar. I: 217.
Kok-tschol. Fo. tr. I: 62.
Kok-tschol-aralı. Stp. The Island of the Little Blue Lake. I: 95.
Kok-tschol-darjasi. Old riv. bd. The River of the Blue Lake. I: 95, 97; II: 535.
Kok-tagh. Mt. The Blue Mountain. II: 62.
Kok-teke. Mt. The Blue Mountain. II: 97.
Kokul. Fo. tr. Poplar with a long naked stem and a thick round crown. I: 59; II: 533.
Koldòlon-kol. La. K. = a lake which lies at right angles to the river which discharges into it. I: 432.
Komur-saldi. Rd. Where Coal was Thrown out. II: 15.
Kona-Abdal. Vil. Old Abdal. II: 152, 212, 214.
Kona-akin. Old riv. br. The Old Stream. I: 468, 478.
Kona-daghilik. Rg. II: 560, 593.
Kona-darja. Riv. bd. The Old River. I: 4.
Kona-darja. I: 14, 18 ff.; II: 530.
Kona-darja. I: 27, 38 ff., 47, 55.
Kona-darja. I: 67.
Kona-darja. Old riv. bd. I: 89, 90, 91, 93, 94; II: 535.
Kona-darja. Riv. bd. I: 120 ff.
Kona-darja. Riv. bd. I: 160.
Kona-darja. II: 544.
Konaghlik. Rg. The Wheat Place. I: 67.
Kona-jaman-jar. Riv. bd. The Old Difficult Terrace. I: 4.
Kona-Jarkent-darja. Riv. bd. The Old River of Jarkent. I: 55, 58, 62.
Kona-kuruk-ettek-kol. Desic. la. The Old Dry Western Lake. II: 512.
Kona-kusch. Old vil. The Old Bird. I: 174.
Kona-kuslek. Des. ho. The Old Autumn Place. I: 176.
Kona-ortäng. Fo. tr. The Old Station. I: 27.
Kona-satma. Des. ho. The Old Hut. I: 498.
Kona-schahr. Ru. The Old City. II: 34.
Kona-schahr. Ru. II: 503.
Kona-schahr-kum-darvase. Gate of Ak-su. Sand Gate in the Old Town. I: 67.
Kön-asti. Dist. The Suspended Leather. I: 425.
Kona-tagirmän. Riv. bd. The Old Mill. II: 5.
Kona-tarim. Riv. bd. The Old River. I: 174.
Kona-tarim. Old riv. bd. II: 511.
Kona-tatran. Stp & des. vil. Old Tatran. I: 383.
Kona-Ugen-darja. Riv. bd. The Old Ugen River. I: 106.
Kona Ulugh-köldake-uj. Old vil. The Old House of the Big Lake. I: 168.
Koncheh-darja. Riv. The River of the Tanner. II: 264.
Kondak-alghutsch. Fo. tr. Kondak is the wooden Stock of a Rifle; where Wood is taken for Rifles. I: 147.
Kongartschak-bel. Fo. tr. The Passage of the Thorny Bush. I: 98, 100.
Kong-koluk. II: 505.
Kong-lugu. St. II: 472.
Kongurtschaktik-kol. La. The Lake of the Thorny Bush. II: 211.
Kongurtschak-tscheke. Fo. tr. The River-Loop of the Thorny Bush. II: 10, 513.
Konkolluk. La. The Root of the Sedge. I: 432.
Kontsche. Riv. The Tanner. II: 347.
Kontsche-bulak. Stm. The Spring of the Tanner. I: 371.

Kontsche-bulak. Vl. II: 309.
Kontche daria. Riv. The River of the Tanner. II: 310.
Kontsche-darja. Riv. I: 128, 151, 155, 160, 174, 182, 205, 234, 301 ff., 354, 367, 425 ff., 444, 454, 457, 474, 478, 487, 493, 497, 499, 502 ff., 509; II: 3 ff., 17, 20, 22, 28, 34, 36, 38, 40 ff., 45, 52, 88 ff., 93, 96 ff., 118, 130, 135, 189, 221, 258, 262, 271, 273, 277, 279, 290, 294, 298 ff., 310 ff., 335 ff., 345, 351, 354 ff., 391 ff., 512 ff., 524 ff., 527 ff., 548, 571, 577 ff., 583.
Koocha (Kutschar). Tn. II: 612.
Koral-dung. Sd. dn. The Watch Hill. I: 111 ff., 115; II: 537, 559, 588, 590.
Koral-dungning-kol. La. The Lake of the Watch Hill. I: 111.
Korat-bulak. Sp. II: 579.
Korghaschun-keni. Mi. The Lead Mines. II: 37, 75.
Korla. Tn. I: 158, 162 ff., 194, 212, 230, 333, 399, 508 ff.; II: 5, 9, 11, 15, 33, 35, 76, 93, 95 ff., 260, 271, 279, 293 ff., 300, 313, 335, 353 ff. 388, 441, 513, 516, 518 ff., 520 ff., 566 ff., 571, 601 ff., 605, 614.
Korot-bulak. Sp. K. = Kara-ot?; the Black Grass Spring. II: 111, 175.
Koruk. Str. rg. The Lagoon. I: 434.
Korum. Fo. tr. The Stony Place: also a current of great velocity. I: 18, 19, 26.
Koschalansa. Wl. II: 174, 579.
Kosch-arik. Ca. The Double Canal. I: 436.
Kosch-arukde-boldschemasi. La. The Deadwater of the Two Canals. I: 288.
Kosch-bulak. Sp. The Double Spring. II: 471.
Kosch-dung-dschaj. Ma. The Place of the Two Hills. I: 63.
Kosch-kotan. Fo. tr. The Two Huts. I: 110, 119.
Kosch-kotan. Fo. tr. I: 126.
Kosch-kotan. Ht. I: 179.
Kosch-lasch. Rg. II: 606.
Koschmet-köl. Old la. K's Lake. I: 400, 401.
Koschmet-kum. Sd. Koschmet's Desert. I: 400.
Kosch-muge. Sd & tms. The Two Horns. I: 159.
Kosch-otak. Str. tr. The Two Homesteads I: 17.
Kosch-toghrak. Str. tr. The Double Poplar. I: 17.
Kosch-toghrak-tscheke. The River-Loop of the Two Poplars. II: 513.
Kose Kirgen-kok-ala. Riv. a. K. K's River-arm. II: 509.
Koselek. Vil. I: 9.
Kosh-bulak. Spr. The Double Spring. II: 472.
Kosu-kirgen. Stm. The Peg Driven down. I: 176.
Kosu-kirgen-köl. La. I: 176.
Kotàk-karaul. Wtch. hs. The Watch-house of the Dry Wood. I: 62.
Kötak-köl. Sd dn. The Dry Woods Lake. I: 69.
Kotàklik. Riv. & rg. The Driftwood Place. I: 22, 25 ff., 52, 65; II: 553.
Kòtàklik. Gn & sp. The Place of the Dry Wood. II: 18.
Kòtaklik-ajaghi. Fo. tr. Termination of the Arm that carries Driftwood. I: 23; II: 553.
Kotàklik-darja. Riv. The Driftwood River. I: 22, 139; II: 530, 558, 588.
Kotaklik-kol. La. The Driftwood Lake. I: 459 ff., 463.
Kotak-tschol. Old la. The Driftwood Pool. I: 420.
Kotaktu-köruk. La. The Lagoon of the Dry Wood. I: 140, 145.
Kotoroma. Bnd. A place where canoes are carried over land. I: 482.
Kotschkar-aghil. Fo. tr. The Ram-fold. I: 79; II: 606.
Kotschkatschi-köl. La. Kotschkatsch's or the Swallow Lake. I: 209; II: 512.
Kotschkatsch-köl. La. K's or the Swallows Lake, I: 186, 207.
Kotsch Kullu-kol. La. K. K's Lake. I: 220.
Kotschok-attamning-koli. La. The Little Fathers Lake. II: 152.
Kovna-Abdal. Vil. Old Abdal. II: 272, 273.
Kua-tschua. Vil. II: 407.
Kuba-ortang. St. The Canal of K. (Kurban?). I: 67, 72.
Kucha. Tn. (= Kutschar.) I: 79.
Kuda. Fo. tr. I: 25.
Kudschek. Riv. bd. The Oar. I: 168 ff., 174, 425, 430, 432; II: 505.
Kudsche-kaldi. Fo. tr. K. Arrived. I: 106.
Kudsche-kaldi. Sd. dn. II: 536.
Kuduk. Wl. The Well. II: 579.
Kuduk-kaulaghan. Rg. Where the Well was dug. II: 503.
Kuei-Tzē-tung-thshuan. Riv. II: 300.
Ku-fi. Sp. II: 99.
Kugek. Dist. A place called for watching in which direction the fish are swimming. II: 150.
Kujdalik. Pge. The Place of the Swans. II: 94, 96, 391.
Kujghu-tschapghan. Ca. K's Canal. I: 224.
Kujlusch. Fo. tr. The Confluence. I: 26.
Kujlusch. I: 54; II: 532.
Kujlusch. Fo. tr. I: 83.
Kujluschning-baschi. Fo. tr. The Upper Part of the Confluence. I: 54, 65; II: 554, 558, 589.
Kujuk-köbruk. Br. The Burnt Bridge. I: 66.
Kujuk-tam. Ho. The Dry Clay House. I: 111.
Kujuk-tam. Ho. The Burnt Clay House. I: 116.
Kujusch. Con. The Confluence. I: 210; II: 560.
Kujusch. Dist. The Confluence. I: 463, 475.
Kuku-nor. La. The Blue Lake. II: 472.
K'uku-schakscha. II: 287.
Kulan-baschi. Gn. & sp. The Kulan's Head. II: 18.
Kulatscha. Dist. & vil. The Mouth of the Lake. I: 207, 209 ff., 465; II: 272, 275.
Kulatscha. Riv. a. II: 550.
Kulatschane-ajagh-tscheke. Lp. Kulatscha's Lower River-Loop. I: 207.
Kulluk Bajning-gumbesi. Brl. pl. The Tomb of K. Baj. I: 65.
Kulluk-tagh. Mt. The Servant's Mountain. I: 66.
Kultschak-koli. Old la. K's Lake. I: 414.
Kultschakning-uji. Ho. K's House. II: 512.
Kultschuk-koli. La. K's Lake. II: 337.

Kultu Bekni-uji. Pl. The House of K. Bek. I: 430.
Kultuk-köli. La. K's Lake. I: 451.
Kultuk-tschapghan. Old. ar. The Canal of K. I: 217.
Kum-agis. Sd. The High Sand. I: 55, 58, 74.
Kum-aral. Sd. The Sand Island. I: 98; II: 535.
Kum-aral. Id. I: 281.
Kum-arik. Vil. The Sand Canal. I: 71.
Kum-arik. Vil. I: 100.
Kum-arik. High-water canal. I: 114.
Kum-arik. Dist. I: 430.
Kum-atschal. Fo. tr. I: 25; II: 530, 553, 558, 588.
Kum-basch. Vil. The Beginning of the Sand. I: 71.
Kum-bulak. Sp. The Sand Spring. II: 287, 471 ff., 523 ff.
Kumdan. Pl. The Brick-kiln. I: 382.
Kumdan. Riv. a. I: 503.
Kumdan-darja. Riv. The River of the Brick-kiln. I: 503 ff.
Kum-darja. Riv. bd. The Sand River. II: 3 ff., 10 ff., 28, 35, 43, 63, 80, 91.
Kum-därvase. Gt. The Sand Gates of Kaschgar. I: 3.
Kum-gerem. Fo. tr. The Sand Hut. I: 62.
Kum-jejnek. Fo. tr. The Sandy Loop. I: 110.
Kum-kätschik. Sd. The Sandy Ford. I: 67.
Kum-kol. La. The Sand Lake. I: 169, 287, 299, 307.
Kum-kol. La. I: 477.
Kum-köl. La. II: 137, 141.
Kum-köl. La. II: 504, 506.
Kum-kotan. Fo. tr. The Sandy Fold. I: 103.
Kum-kujuk. Fo. tr. The Eroded Sand. I: 64, 67; II: 533.
Kum-kujulma. Sd. The Eaten away Sand. I: 397 ff.
Kumluk. Inh. tr. The Sandy Place. I: 67.
Kumluk. Dist. I: 425, 428.
Kumluk. Dist. I: 502.
Kumluk. Lp. I: 502.
Kum-modschuk. Str. rg. The Sandy Cape. I: 467.
Kum-saghilghan. Stp. The Gliding Sand. I: 382.
Kum-tagh. Dst. The Sand Mountain. II: 173, 175, 222, 382 ff., 392 ff., 399 ff., 446 ff., 471, 483, 485 ff., 500.
Kum-tau. Dst. The Sand Mountain. II: 386 ff.
Kum-tok. Pl. The Sand Dam. I: 430.
Kum-tokaj. Fo. tr. The Sand Forest. I: 17.
Kum-tschakil. Fo. tr. The Sandy River-Loop. I: 34.
Kum-tschakil. Vil. I: 66.
Kum-tschakma. Sd. Where the River has Eaten away the Sand. I: 399, 398.
Kum-tschapghan. Vil. The Sandy Channel. I: 219, 437, 441, 444, 459, 497; II: 131, 133 ff., 139 ff., 143, 146, 149 ff., 154 ff., 159 ff., 170, 175 ff., 184, 194, 201, 208 ff., 225, 275, 283, 329, 359, 520, 548, 551, 560 ff., 568 ff., 581, 591 ff., 595.
Kum-tschaval. Dst. The Sporadic Sand. I: 348.
Kum-tscheke. Dn. & fst. The Sandy Promontory. I: 141.
Kum-tscheke. Dist. I: 207.
Kum-tscheke. Vil. I: 430, 450 ff., 458, 462, 465 ff., 472 ff., 478, 486, 490; II: 330, 513, 556, 561, 590, 596.
Kum-tscheke. Fo. tr. II: 11.
Kum-tscheke (Ilek). Riv. II: 342.
Kumuschi. Desic. la. The Reeds. II: 86.
Kumuschin-tuse. Desic. la. II: 86 ff.
Kumusch-satma. Fo. tr. The Reed Hut. I: 58.
Kumuteluk. Fo. tr. The Mosquito Place. I: 95.
Kungul-koschu-boltasi. Sou. The Double Sound of K. I: 255.
Kuntei-bulak. Sp. The Sunny Spring. II: 285.
Kuntej-keste. Fo. tr. The Cut Hollow Trunk. I: 62.
Kun-tö-i-pu-k'ö-la. St. II: 285.
Kuntschekan-kobrughu. Str. rg. K's Bridge. I: 434.
Kuntschekan-uktusu. La. K's Little Lake. I: 169.
Kuntschekar-tarim. Riv. The Eastern River. I: 425.
Kuntschekisch-sala. Riv. br. The Eastern River-Branch. I: 487, 492.
Kuntschekisch-tarim. Riv. The Eastern River-Branch. I: 204, 424 ff., 433, 486, 493, 497 ff., 509; II: 9 ff., 299, 336, 512 ff., 518 ff., 546, 548, 561, 594, 596.
Kurban Bekning-ilesi. The Sign-post of K. Bek. II: 504.
Kurban Bekning-teremi. Riv. a. The River-arm of Kurban Bek. II: 504.
Kurban-dschajiri. La. The Lake of K. I: 181.
Kurbane-uji. Vil. K's House. I: 186.
Kurban-koli. Old. la. K's Lake. I: 429.
Kurban Kullu. Str. rg. The Place of K. K. I: 430.
Kurban Kullu-jatghan. Dist. The Tomb of K. K. I: 412, 414.
Kurban Kulluni-köli. La. The Lake of K. Kullu. II: 194.
Kurban-Kulluning-terem-baschi. The Beginning of K. Kullu's River. II: 505.
Kurban Pavaning-tägirmän. Ml. The Mill of K. Pavan. II: 509.
Kurban Supaning-birintschi-tschapghani. Ca. The First Channel of K. Supa. II: 504.
Kurban Supaning-ikintschi-tschapghani. Ca. The Second Channel of K. S. II: 504.
Kurban Supa-tschapghan. Str. rg. & ar. The Channel of K. S. I: 214.
Kurbantschik. Gn. Kurban's Place. II: 21 ff., 95 ff., 524.
Kurdscheklik. Fo. tr. The Place of the Oars. I: 52.
Kurgek. St. II: 176.
Kurghan. Ft. The Fortress. I: 216; II: 504.
Kurghan-bulak. Sp. The Spring of the Fortress. II: 283, 286, 472.
Kurghan-davan. Ps. The Pass of the Fortress. II: 286, 291.
Kurghan-saj. Vl. The Valley of the Fortress. II: 286.
Kurghan-sajning-aghis. Vl. The Entrance of the Fortress Valley. II: 286.
Kurle (Korla). Tn. II: 287, 611.
Kurlik-uj or Kurlalik-uji. Fo. tr. II: 10.
Kurme. Fo. tr. Kurm or Kurma is a kind of provisional hut formed by branches or poles, and often also with clay. I: 74.
Kurm-uj. Dist. The Hut of Branches (or Poles). I: 431 ff.
Kurruk-tag. Mt. The Dry Mountain. II: 93.
Kurtsch-aghil. Str. rg. The Lamb-fold. I: 379, 381.

Kurugen-ögen. Riv. bd. The Dried-up »Ogen». I: 141, 142, 144: II: 560.
Kurugen-ugen. Riv. The Dried up »Ugen». II 539, 556, 590.
Kurugh Tagh. Mt. The Dry Mountain. II: 97.
Kuruk-akin. Gn. The Dry Stream. II: 21.
Kuruk-asti. Vil. Properly: Kujruk-asti = the Suspended Tail. I: 34, 36 ff., 41, 54, 64 ff., 68; II: 470, 554, 458, 588.
Kuruk-darja. Riv. bd. The Dry River. I: 102 ff., 155 ff., 404, 414, 437, 439; II: 28, 35 ff., 41 ff., 56 ff., 66, 68 ff., 88, 105, 115 ff, 165, 168, 225, 235, 258, 262 ff., 289, 293, 295, 299 ff., 305, 331, 333, 336, 340, 348, 354 ff., 363, 437, 451, 454, 515, 520 ff., 536, 571, 577 ff., 582 ff.
Kuruk-kobruk. Br. The Dry Bridge. I: 59.
Kuruk-kobruk. Sd. dn. I: 60.
Kuruk-kobruk. Riv. bd. I: 63.
Kuruk-ögen. The Dry »Ogen». Ri. I: 110, 113.
Kuruk-tagh. Mt. The Dry Mountain. I: 150, 354, 364, 437, 509; II: 4, 11, 13 ff., 23 ff., 36 ff., 40, 58, 61 ff., 66 ff., 73, 76 ff., 100, 102, 104, 107, 110 ff., 121, 133, 173, 175, 185, 201, 221 ff., 244, 284, 287, 289, 291, 306, 348, 357, 368, 392, 397, 439, 452 ff., 461, 466 ff., 471, 475, 484, 494, 497, 523 ff., 579, 582 ff.
Kuruk-tarak. Vil. The Dry Poplar. I: 66.
Kuruk-taurak. Os. The Dry Poplar. II: 82, 83.
Kuruk-toghrak. The Dry Poplar. II: 78.
Kusch. Vil. The Bird. I: 431.
Kuschke. Fo. tr. The Street. I: 49.
Kusch-o ji-davan. Ps. The Pass of the Bird's Nest. II: 77.
Kuschtsche-gumbesi. Ma. The Tomb of K. I: 71.
Ku-schui-cha. Sp. II: 471.
Kuslek. Str. & des. vil. The Autumn Place. I: 175, 185, 508.
Kuslek-mähällasi. Vil. The Autumn Village. II: 505.
Kuslik. Pl. The Autumn Place. I: 420.
Kusuptschi. Dst. II: 380.
Kutlekmetning-uj. Fo. tr. House of Kutlek Muhamed. I: 116.
Kutschar. Tn. I: 83, 89, 91, 94, 100, 105, 111, 126; II: 293, 307, 513, 525, 535, 566, 567, 602, 605, 611, 614.
Kutschmet. Dist. Name of a man. I: 404; II: 341.
Kutschuk-attam. Vil. The Little Father. II: 152.
Kutuk Begi-koli. Str. rg. K. Beg's Lake. I: 502.
Kutuschtu-arighi. La. I: 147.
Ku-tutghan-kol. La. The Lake of the Caught Swan. II: 511.
Ku-tuttu. La. Where the Swan was Caught. I: 204, 205.
Ku-tutu-kol. La. The Lake of the Caught Swan. I: 182; II: 511.
Kwen-lun. Mts. I: 77, 327, 383; II: 28, 76, 407, 516, 521 ff., 527, 565.
Kysyl-kum. Dst. The Red Sand. II: 444.

Laj-baskan. La. Filled with Silt. I: 287.
Laj-baskan-kol. La. The Silt-filled Lake. I: 290, 307; II: 590 ff.
Lajlik. St. & vil. The Silty Place. I: 3, 10, 12 ff., 16, 25, 54, 58, 64, 91, 144, 147: II: 450, 464, 466, 520, 538, 542 ff., 553, 558, 560, 570, 574 ff., 588, 590 ff.
Lajlik-darja. Riv. bd. The Muddy River. I: 88, 94, 460 ff.; II: 561, 580, 594, 596.
Lajlik-darjasi. Riv. I: 92: II: 534.
Lajlik-tarim. Riv. The Muddy River. I: 473.
Laj-su. Dist. The Silt Water. I: 132, 134, 146, 149; II: 513.
Laj-su. Vil. I: 400, 508, 510.
Laj-tschapti. La. Filled up with Alluvium. I: 141.
Lakone-teresi-kalghan-kol. La. The Lake where the Skin of the Big Fish was Left. II: 142.
Lakuluk-kol. La. The Lake of the Big Fish. I: 175; II: 560.
Lakulluktake-uj. Ht. The House of the Big Fish Place. I: 175.
Lakuluk-kol. La. The Lake of the Big Fish. I: 287, 307.
Lakuluk-kol. La. II: 507.
Lakuluk-tarim. Riv. br. The River with the Big Fishes. II: 507.
Lalmoj. Msh. I: 38, 40, 66; II: 303, 532.
Lalmoj. La. I: 67.
Lampa-akin. Riv. L. is a hut made of poles; the Hut of the Current. I: 111 ff.
Lanka. Fo. tr. A Fence for keeping out Cattle. I: 103 ff.; II: 555.
Lanka. Stm. I: 507 ff.
Lanka-kok-alasi. Chl. The Channel of the Fence. I: 507.
Lan-tschou. Tn. II: 380.
Lao-Lan. Ctry. II: 300.
Lao-Lan-Hai. La. II: 300.
Lap-chi-tjuentsa. Sp. II: 471.
Laschin. Riv. Spot for Sowing the Bank of a River. I: 184, 430.
Laschin-darja. Riv. I: 183 ff., 190, 406, 425, 428 ff., 433, 486 ff., 493 ff., 499 ff., 505; II: 356, 505, 546 ff., 591.
Laschin-kadaghan. Old la. I: 502.
Laschkar-satma. Str. rg. The Hut of the Troops. I: 382, 384, 391.
Laschkar-sokuschkan-kum. Sd. The Sand where the Armies Fought together. I: 116.
Laschlik. Fo tr. The Algæ Region. I: 26.
Laschlik. Str. rg. I: 88 ff.; II: 470, 534, 553 ff., 558, 588 ff.
Latschin. St. A kind of small Falcon. II: 150, 174 ff.
Lau-lan. Ctry. Ru. II: 307.
Leh. Tn. II: 580.
Lenger. Csai. The Station-House. I: 10.
Lenger-dung. Hl. The Hill of the Station House. I: 372.
Leou-lan. Kdm. II: 204, 312.
Lepscheme. Fo. tr. A Level Tract Inundated from the river. I: 24; II: 588
Leu-lan. Kdm. II: 260, 263 ff., 300.
Lhasa. Tn. II: 121, 470.
Libyan Desert. II: 400, 436.
Libye. Dst. II: 450.

Lin-Hai. La. II: 300.
Ljan-tschou. Tn. II: 382.
Lob. Rg. II: 260, 263, 270.
Lob. Tn. II: 265, 301.
Lob-nor. La. II: 259 ff., 278, 306 ff., 310 ff., 353.
Lob-nor. Rg. II: 265, 306.
Lob-nor. Dst. II: 306 ff.
Lob-nortsi. Trb. II: 262.
Lob-nur. La. II: 300.
Lobo-nur. La. II: 312.
Lolo Kullunu-uktasi. La. The Little Lake of L. Kullu. I: 180.
Lop. Ctry. I: 78 ff., 91, 109, 111, 127, 158, 182, 188, 191, 222, 230, 247, 292, 294, 301, 305, 328, 351, 361, 364, 383, 221, 461, 482, 492, 508, 510; II: 12, 34, 38, 82 ff., 97, 100 ff., 133, 178, 207, 210, 262, 275, 283, 295, 306, 308, 310, 312, 348, 354, 357, 361, 397, 439, 467, 546, 565 ff., 574, 577 ff., 581 ff., 598, 603, 606 ff.
Lop. Vil. I: 219, 398 ff., 403, 510; II: 272, 339, 504, 547, 611, 614.
Lop. Dst. I: 245, 280, 292 ff., 317, 361, 367 ff., 399, 404, 408, 437 ff., 446, 460, 465 ff., 484, 512; II: 3, 30, 47 ff., 63, 66 ff., 95, 98 ff., 113 ff., 125 ff., 132, 164 ff., 170 ff., 174 ff., 183, 187 ff., 193, 210, 214, 222, 224, 228, 233 ff., 244 ff., 253, 257, 262 ff., 270, 274, 304, 306, 313 ff., 324 ff., 333 ff., 348, 355 ff., 364, 366, 370, 390, 397, 405, 414, 430 ff., 442, 451 ff., 460 ff., 471, 482 ff., 490, 552, 576, 578 ff., 582 ff., 608, 619.
Lop. La. II: 97, 121.
Lop. Tn. II: 301.
Lop. Bsn. II: 329, 345, 525, 569, 571, 577.
Lop-koli. La. I: 399, 400, 402.
Lopning-ortang. St. hs. The Station-House of Lop. II: 504.
Lop-nor. La. I: 154 ff., 245 ff., 303, 312, 322, 333, 379, 384, 392, 402, 408, 413 ff., 438, 463, 469, 479, 482, 497, 510, 512; II: 4, 11, 15, 34 ff., 43, 63 ff., 83 ff., 90 ff., 107, 115, 118, 128, 140, 148, 168 ff., 185 ff., 195, 199, 202, 210, 226, 230, 235,, 241, 245, 247 ff., 258 ff., 270 ff., 280 ff., 290 ff., 300 ff., 310 ff., 326 ff., 330 ff., 340 ff., 354 ff., 361 ff., 370 ff., 382, 388 ff., 400, 450 ff., 458 ff., 461, 469, 472, 475, 483, 486, 489, 515, 520, 527, 574, 577, 581 ff., 612, 623.
Lop-nor. Bsn. II: 90, 91, 97.
Lop-nor. Ctry. II: 269.
Lop-nur. La. II: 276, 278, 287 ff., 290.
Lopu-nor. Dist. I: 504.
Lo-tschen. II: 38.
Lôu-lan. Old Tn. II: 35, 64, 88, 116, 118 ff., 174, 178, 210, 214, 227, 231, 233 ff., 257 ff., 264, 276 ff., 288, 290, 295, 300 ff., 312, 314, 325 ff., 437, 454, 468 ff., 521, 577, 581, 584, 619 ff.
Lou-Lan. Ctry. II: 300.
Lôu-lan-hai. La. II: 349.
Lôu-nor. La. II: 312.
Lovo-nur. La. II: 312.
Luktschun. Dpr. II: 25, 37 ff., 78 ff., 83, 85, 87 ff., 98, 387, 399, 402.
Lung-tschong. Tn. II: 301.
Lun-tiai. II: 300.

Madscha. Vil. I: 6.
Ma-ge-tschen. Riv. a. II: 373.
Mahametning-kudughi. Wl. Muhamed's Well. I: 9.
Mahametning-koli. La. M's Lake. II: 508, 509.
Mahmetne-modschughu. Prm. M's Cape. I: 255.
Mahmet-tschekan-dung. Hl. I: 436.
Majtu-kaldi-kol. La. II: 513.
Ma-lan-tschuan. Wl. II: 99.
Mal-pischti. Fo. tr. Where the Sheep were washed (to get the wool clean). I: 97.
Maltak-kol. La. I: 427 ff., 507; II: 345, 512, 548.
Maltak-koli. La. II: 513.
Mamuschning-ujdake-tscheke. Ho. The Bend of Mamusch's House. I: 513.
Manan-kotan. Fo. tr. The Hat of the Fresh, Young Kamisch. I: 88
Manassarowar. La. II: 5.3.
Manchuria. Prov. II: 382.
Mandarlık. Vl. II: 586.
Mandschar. Pl. M. A kind of Net. I: 427.
Mandschar-baschi. Str. krg. The Uppermost Place for Setting out Fishing Nets. I: 185, 493, 497, 502.
Mandschar-baskan-ilek. Riv. br. The River with the Suspended Net. I: 483.
Mandschar-kol. La. The Net Lake. I: 116, 118.
Mane or Majni. Fo. tr. Probably the Mongol Mane, stone with inscription. II: 10.
Mangischlak. Pen. The Place of Movement. II: 446.
Manitu. St. II: 287, 291.
Mantscha. Fo. tr. A kind of Net. I: 104.
Mapa-kisil-kul. II: 293.
Mäpaschlik. Fo. tr. The Region of the Poplars that have Grown together. I: 388.
Maral-baschi. Tn. The Head of the Stag. I: 12, 16, 21, 26, 36, 38, 49, 66 ff., 78; II: 353, 449, 529 ff., 533, 544, 566, 582, 600 ff., 605, 611, 613.
Märdak-kol. La. I: 463, 466 ff., 473; II: 363.
Mardäk-schahr. Ru. I: 468; II: 561.
Mardaktik. Vil. I: 462 ff.
Margelan. Tn. II: 586.
Markat. Str. rg. Masar, Burial-Place. I: 182, 305, 482; II: 331, 340, 343, 347, 370, 579, 582.
Markatdake-kona-uj. Des. vil. The Old House of the Burial-Place. I: 182.
Masalik. Rg. I: 59, 63.
Masar. Brl. pl. The Holy Man's Tomb. I: 435; II: 505.
Masar. Fo. tr. II: 10, 22.
Masar-aldi. Vil. Before the Masar. I: 36, 40, 65.
Masar Chodscham. My Lord's Masar. Ma. I: 55, 59.
Masar-dung. Ma. The Masar Hill. I: 80.
Masarem. My Masar. II: 505.
Masar-tagh. Mt. The Masar Mountain. I: 34, 36, 38, 43, 69, 73; II: 303, 455, 477.
Maseni-ilegi. Riv. a. M's River. I: 512.
Matan. Vil. I: 64, 67, 71, 82; II: 470, 533, 554, 559, 589, 605.
Matija-jatghan. Pl. M's Grave. I: 425.
Matijasi-kotanu. La. M's Hut. I: 432.
Matijasi-togh. La. M's Dam. I: 432.

Matijas-jatghan. Pl. M's Grave. I: 502.
Matijas-soretmesi. Str. rg. M's Portage. I: 502.
Matija-sorotmesi. Str. rg. M's Portage. I: 427.
Matischim-dung. Hl. The Crescent-shaped Hill. I: 92.
Matschit. Ru. The Mosque. I: 386.
Matschit-dung. Fo. tr. The Mosque Hill. I: 89.
Meghna. Riv. a. II: 333.
Mejim Kuli Busrugvar. Ma. I: 73.
Mejnet. Vil. & st. Poor Devil, Good-for-nothing. I: 8, 16; II: 543 ff.
Menglighi-tschakmaka-kalghan. Old pge I: 183.
Mengligi-ilegi. Riv. M's River. I: 427.
Mening-tschokon. Bol. Where M. was Drowned. I: 213.
Merdek. Rg. II: 272.
Merdek-kol. La. The Lake of M. II: 301, 596.
Merdek-schahr. Old tn. The City of M. II: 33 ff., 272, 301.
Merdek-tarim. Riv. I: 207.
Merket. Vil. I: 16; II: 455, 544, 590 ff., 603.
Mian. Rit. = Murén. I: 224.
Mijan. Os. = Murén. II: 132, 135, 139, 216.
Mijan-ajaghi. Rit. The Lower Part of Mijan. II: 216.
Mijan-baschi. Gn. The Upper Part of Mijan. II: 217.
Milka. Fo. tr. I: 48, 95; II: 532, 554, 558, 589.
Mil-toksun. Rvn. Sp. A Man's Name = Mir Toktasun. II: 80, 84.
Ming-sha-shan. II: 395.
Mir-toktasun. Sp. Man's Name. II: 77, 84.
Mitt. Riv. II: 522.
Mo-chur-sen. Mn. Miserable Dry Mountains. II: 37.
Modsche-toghrak. Ppr. gr. The Poplar Promontory, because a quantity of driftwood has got entangled in a poplar in the bed, forming a kind of cape. I: 87; II: 534, 554, 589, 590, 591.
Modschuk-kotan. Str. rg. The Hut on the Cape. I: 502.
Modschu-kotan. Ht. The Hut on the Cape. I: 429, 493; II: 596.
Modschuk-toghrak. Fo. tr. The Poplar Cape. II: 217.
Moessining-uji. The House of the Priest. II: 505.
Moghal. Vil. The Mongol. I: 7, 8.
Moghal-satmasi. Fo. tr. The Mongol's Hut. I: 53.
Mogutun-gol. La. II: 371, 374, 375.
Mokme-kol. La. II: 194.
Moldscha. Riv. I: 373, 375 ff., 379; II: 348, 522 ff.
Moldscha-darja. Riv I: 375.
Mollamet-bulak. Sp. The Spring of Molla Muhamet. II: 77.
Momum-ottogho. Fo. tr. The Dwelling-Place of M. I: 150; II: 559, 599.
Monan-salghan. Sh tr. The Settlement of M. I: 281.
Mongolia. Ctry. II: 380, 384, 441.
More. Fo. tr. The Fire-Place. I: 47; II: 554, 558, 589.
Motel-uktusi. La. The Little Lake of M. I: 198.
Motel-uktusu. La. I: 237.
Muchlaj-bulaghi. Sp. Muchlaj's Spring. II: 62.
Muchlaj-bulak. Sp. II: 77.
Muchursein. Mt. II: 90.
Mudschi. Vil. II: 604.
Muchursejn. Mt. II: 38.
Muhamed Aru. La. A Man's Name. I: 175.
Muhamed Aru-kol La. M. A's Lake. I: 287; II: 507.
Muhamede-godsche-tutghutschtake-uji. Ht. The House where M. Collected Feathers. I: 190.
Muhamede-karaul-dung. Dn. The Watch Hill of M. I: 190.
Muhamede-koschuru. II: 215.
Muhamede-mutschekan-uji. Dist. I: 189.
Muhamed-kalgen-kotan Ht. The Hut to which M. Came. I: 174.
Muhamed Kulluning-uji. Des. sa. The House of M. Kullu. I: 126.
Muhamed Kullunu-modschughu. Cp. The Cape of M. Kullu. I: 281.
Muhamed Mirab-arighi. Dry ca. The Canal of M. M. I: 124.
Mahamedne-koli. La. M's Lake. I: 176.
Muhamedne-koli. La. I: 287.
Muhamed Niasning-arighi. Ca. M. Nias' Canal. I: 114.
Muhamed Nias-osasidake-arik. Ca. The Canal of M. N's Deserted Fields. I: 511.
Muhamed Nias-salghan. Sh. tr. The Settlement of M. N. I: 281.
Muhamed Nias-tschadirning-uj. Ht. The House of M. N's Tent. I: 428.
Muhamedning-baschtaghe-kol. La. The Upper Lake of Muhamed. I: 297.
Muhamed Sopane-modschuk. Cp. The Cape of M. Sopu. I: 281.
Muhamed Supaning-satma-uji. Ho. The Hut House of M. Supa. II: 596.
Muhamed Supa-uj. Vil. M. S's House. I: 169.
Mahamed-uji. Ht. M's House I: 181.
Muhammed-Ili-lenger. Csat. M. I's Station. I: 14.
Mukurning-koli. La. Mukur's Lake. I: 95.
Mulken-ager-kol. La. The Lake of the Many Saddles. I: 145.
Multuk-kojghan. Rg. The Rifle Put away. II: 503.
Munghus-asti. Fo. tr. The Suspended Horn. I: 124.
Mungus-asti. Str. rg. I: 214; II: 470.
Mupte-toghrak. Fo. tr. The Poplar of the Mufti. I: 27.
Muptu Achune-modschughu. Prm. The Mufti Achun's Cape. I: 255, 259, 299.
Murabning-kol-kakmasi. La. The Bay of Murab's Lake. II: 510.
Muran. Os. The River. II: 132.
Murat Kasmi-putalimki-uji. Ht. I: 186.
Muren. Rit. The River. I: 224.
Muren-ajaghi. Al. tr. The Lower Part of the River. I: 224.
Mus-art-darja. Riv. The River of the Icy Pass. I: 99; II: 525, 527, 535, 555, 557, 626
Mus-asti. Fo tr. The Suspended Horn. I: 124, 126, 214.
Musa-utschanghan-kum. Sd. I: 115.

Musluk-saj. Vl. The Icy Valley. II: 471.
Musulman-natschuk. Vil. I: 4.
Muti Achun-ulturghan-ak-tarma-uj. Des. vil. The House on the Field where M. A. was killed. II: 505.

Nadschi-bidschin. Dist. I: 308; II: 216, 503 ff.
Na-fo-po. Kdm. II: 204.
Naidschin-gol. Riv. II: 370.
Nakara-chane. Fo. tr. The House of the Drum. I: 53, 60.
Nakas. Fo. tr. The Avaricious? I: 18.
Nalugei-khuduk. Wl. II: 201.
Nam-kol. The Wet Lake. II: 504.
Nanambal. Vl. See Kan-ambal and Anambar. II: 472.
Nan-schan. Mts. II: 75, 88 ff., 99, 102, 371, 373, 380, ff., 441.
Nan-schan-schor. Dep. II: 90.
Nan-tschan. Mt. II: 75.
Napaei. Ctry. II: 312.
Na-po-po. Ctry. II: 312.
Natschuk. Vil. I: 4.
Negetschagh-asghan. Dist. The Suspended Ass Saddle. I: 306, 308.
Ngan-Hwej. II: 443.
Nias Bekni Attamne-koli. La. The Lake of N. Bek's Father. I: 187.
Nias Bekni-koli. La. N. B's Lake. I: 187, 188.
Niasdake-uj. Hs. The House of Nias. II: 283.
Nias Hakim Bek-tuschken. Str. rg. Where N. H. B. Encamped. I: 150.
Nias-kol. La. The Lake of N. I: 459, 463; II: 265, 272, 275, 338, 548.
Niasmetning-kok-alasi. Bol. The River-Arm of N. Muhamet. I: 420.
Nias Supa Bajne-uji. Old vil. N. S. Baj's House. I: 168.
Nias Supa Bajning-uji. Dist. I: 435.
Niei-mo. Ctry. II: 264.
Nija. Dist. I: 314, 370, 375, 381; II: 270, 296, 388, 570.
Nija. Tn. II: 605.
Nija-darja. Riv. I: 70, 302, 373; II: 348, 522 ff., 571, 606.
Nil. Riv. II: 308, 459.
Nile. Riv. II: 333.
Ning-tschao-ljang. Tn. II: 380, 382.
Niser Kulluning-boltasi. La. The Sound of N. Kullu. II: 508.
Nodsche. Dist. Ambush, made of branches, used by hunters when waiting for wild animals. I: 430.
Noghussun-tu. Sp. The Duck Spring. II: 63, 571.
Nuki-bulak. Sp. The Spring of N. II: 283.
Nuki-dakia-tarim. II: 283.
Nukidake-tarim. Riv. Nuki's River or Arable Land. II: 283.
Nuki-davan. II: 283.
Nukitu II: 283.
Nukitu-daban. Ps. II: 277, 278, 281, 282, 283, 285, 286.
Nukitu-davan. Ps. II: 286.
Nukitukia-daban. Ps II: 283.
Nukitukia-sekin. Pl. II: 283.
Nukitu-ling. Ps. II: 278, 291.
Nukitu-qia-Tarim. Riv. II: 282, 286, 293, 295.
Nukitu-schan-k'ou. The Mouth of the Mountains. II: 278, 282, 284, 286, 292, 293.
Nukitu-sekin. II: 282, 283, 284, 286.
Nukitu-setsin. II: 278, 282, 283, 286.
Nukus. Pl. II: 293, 294.
Numet-bulung. Fo. tr. N's Bay or Corner. I: 50.
Numet-tschapghan Dug by Numet. I: 130.
Nurma. Fo. tr. A Fallen Terrace. I: 50.
Nuruma. Dist. I: 188.
Nutsitu. Mt. II: 278

Ob. Riv. II: 367, 372.
Obulang. St. II: 201.
Odschuluk-kol. La. The Sedge Lake (odschul is part of a sedge stalk, which can be eaten). I: 433.
Ogen. Riv. I: 102, 110, 128, 145; II: 536.
Ogen-darja. Riv. I: 118, 128, 137.
Oghri-bulak. Sp. The Thief's Spring. II: 77.
Oghru-tepgen; the Box that is Hammered together, forest tract on the lower Tarim, not in the text.
Oghru-tschapghan. Pl. The Thief's Canal. I: 430.
Oghu Dschanghu Vardi-tarim. Riv. O. D. V's River. I: 187.
Ojen-aldi-kol. La. The Lake in Front of the House. I: 440.
Oj-kobruk. Os. The Deep Tamarisk Place. II: 53, 63.
Ojman-bulak. Sp. The Deep Spring. II: 75, 78.
Ojman-kol. La. The Deep Lake. I: 183, 220, 287 ff., 296; II: 511, 569.
Ojman-kol. Vil. I: 183; II: 508.
Ojman-koldake-uj. Ho. The House of the Deep Lake. II: 510 ff.
Ojman-kol-kischdake-uji. Des. ho. The Winter Domicile of the Deep Lake. I: 183.
Oj-toghrak. Vil. The Poplar of the Deep Place. II: 604.
Okesch. Vil. I: 7.
Oketsch-kotan. Fo. tr. The Hut upon the Narrow Neck of a River-loop. I: 105.
Okhur. St. II: 201.
Okur-tagh. Mt. I: 66.
Olturghan-bulak. Sp. The Killing Spring. II: 84.
Olun-temen-tu. Sp. The Spring with the Many Camels. II: 25, 63, 72, 75, 82, 88 ff.
Oluntimentu. Gn. & Sp. II: 72.
Ondortu. II: 206.
Opghan. Riv. br. The Removed. I: 113.
Opghan-darja. Riv. bd. The Removed River. I: 127 ff., 131 ff., 137 ff., 144, 156; II: 538.
Opur. Fo. tr. I: 97.
Ordak-jaghutsch-tarim. Riv. The River where Ducks are Eaten. I: 474.
Ordak-jeghan-kol. La. The Lake where Ducks are Feeding. I: 144.
Ordan-Padschah. Ma. I: 364; II: 368, 407, 464, 466.
Ordek-jaghutsch-ilek. Riv. a. O. j. is said to be the name of a plant; but also means Where the Duck was Eaten. I: 403.

Ordos. Prov. II: 380 ff., 441.
Örkasch. Sp. A Man's Name. II: 37.
Or-kou-hai-thu. La. II: 288 ff.
Orku-nor. La. II: 381.
Orlesch. La. Balik orlaitighan jer = Where the Fish Swims against the current, over a broad, shallow place; also a threshold below a narrow passage. I: 432.
Ormang. Fo. tr. I: 100.
Ormat-oldi. Fo. tr. with la. Where O. Died. I: 145.
Ormek-tscheke. Ho. The Bend of O. II: 513.
Orosaning-uji. Ht The Russian's House. I: 142.
Orosuning-uj Fo. tr. and ho. I: 127.
Oro-tscheke. Fo. tr. The Middle Promontory. II: 10.
Ortang. Vil. The Station. II: 135 ff., 170.
Ortang-bulak. Gn. The Station Spring. II: 21.
Ortang-dschajir. La. The Station Lake. I: 188.
Ortang-jol. Rd. The Road with Stations. II: 37.
Ortang-kol. La. The Lake with the Station-house. II: 211 ff., 214 ff.
Osagh-koghul. Sou I: 477.
Osch. Tn. II: 586.
Oschka-oldi. Fo. tr. Where the Goat Died. I: 47.
Osman-baj-kuduk. Wl. O. B's Well. I: 372.
Otăk-kaldi. Riv. a. The Lost Shoe. II: 500
Otak-kol. La. The Village Lake. I: 183.
Otak-kol. La. II: 130.
Ot-kalaghutsch-dung. Hl. The Hill where the Fire is Kindled. I: 174.
Otok-kol. La. The Camping-Place Lake. I: 424.
Ottak-kol. La. The Village Lake. I: 207; II: 510.
Ottok-kaldi. Old riv. bd. The Forgotten Shoe. I: 176, 177.
Ottok-kol. La. The Camping-Place Lake; ottok in connection with kol is also said to mean a lake in which fishes exist. I: 432.
Ottora-kol. La. The Middle Lake; a deep water with much fish is also called ottora-kol. II: 146.
Ottuk-tcheke. Riv. lo. The Inhabited Part of the River Bank II: 505.
Ottus-kemi. Old st. dn. The Thirty Canoes. I: 55, 67, 60.
Otun-bulak. Sp. The Firewood Spring. II: 117.
Otun-nodscha. Sp. The Firewood Ambush (for a Hunter). II: 78.
Ouargla. II: 460.
Ova. Pl. The obo. I: 508.

**P**achma-masar. Bol. Pl. The Asclepias Tomb. I: 72.
Pajek-tschapghan. Riv Rg. P's Canal. I: 403.
Paka-kuduk. Wl. The Frog Well. I: 375.
Pakalama-toghrak. Ppr. gr. II: 217.
Pakhpuluk. Rg. II: 611.
Pakpak-toghrak. Stp. I: 383.
Palas-japti. Rg. Where the (old worn out) Carpet was Wrapped round (somebody). I: 58, 67.
Palevan-kum. Sd. The Hunters Desert. I: 115.
Pa-lin-chai. La. II: 373.
Palta-tuschken-tscheke. The Bend where P. Encamped. II: 513.
Paluan-bulak. Sp. The Hunter's Spring. II: 70, 82.
Palvan-bulak. Sp. The Hunter's Spring. II: 70, 90.
Paman. Fo. tr. I: 103.
Pamir. Mt. I: 4, 74: II: 270, 340, 368, 522, 565, 586.
Pamirskij Post. Fortress. II: 586.
Pan-scha-bulak. Sp. II: 111.
Partscha-kumusch. Fo. tr Isolated Kamish Field. I: 61.
Partschalik-kol. La. The Isolated Lake. I: 115.
Partscha-schor. St. The Isolated Salt-marsh. II: 170.
Pasa Begning-bulaghi. Sp. The Spring of P. Beg. II: 37, 87.
Pasa Bekning-bulak. Sp. II: 38.
Paschalik. Fo tr. The Gnat Place. I: 72
Paschalik-otak. Str. rg. The Gnat Place. I: 102.
Patma-olgen-uj. The House where P Died. II: 505.
Pavan-bulak. Sp. The Hunters Spring. II: 70, 113.
Pavane-bulaghi. Sp. The Hunters Spring. II: 78 ff.
Pavane-kotanu. La. The Hunters Hut. I: 432.
Peghan-kum. Sd. I: 115: II: 537.
Peking. Tn. II: 311, 380.
Peres. Str. Rg. The Leprous. I: 90 ff; II: 580.
P'e-schan. Mt. II: 102, 105, 111, 118, 121.
Petelik-otak. Fo tr. The Dwelling-Place at the Grazing. I: 25: II: 530.
Pitschak-sindi. Vil The Spoilt Knife. I: 40, 65 ff., 60.
Pitschan. Riv. II: 384, 387—389, 390, 446.
Po-dschun-sa. St. II: 37, 38.
Podschunsa. Dist. and vl. II: 38, 86 ff.
Podulaklik-kol. La. Water-lily-lake. I: 477.
Podung. Fo. tr. po = bast of poplar, used as tinder; dung = hill. I: 97.
Po-jang. La. II: 443, 447.
Polotto-boltasi. Sou. P's Sound. I: 281.
Porutschi-kotan. Fo. tr. P's Hut. I: 94.
Posgham. Vil. II: 543, 604.
Potgho-kol. La. P. is a kind of algae. I: 160
Pou-tchang hai. La. II: 311.
Psan. Vil. II: 604.
Pschujluk. Fo. tr. Pschuj = a bird of prey. I: 61.
Pushan-saj. Vl. II: 472.
Putalik-kol. La. I: 183, 189 ff.: II: 547.
Putarlik-kol. La. II: 511.
Putej-bajir-kol. La. The Depression Lake without Inflow. II: 526.
P'u-thshang. Msh. II: 301.
P'u-Thshang-Hai. La. II: 300.

**R**ahmaning-koli. La. Rahma's Lake I: 144.
Rahmaning-kolning-ajaghi-kol. La. The Lake below R's Lake. I: 144.
Rahmaning-korughi. Fo. tr. The Lagoon of R. I: 145.
Rang-kul. La. II: 522.
Raskan-darja Riv. I: 11: II: 205, 516 ff., 541
Rehim Jol Begi Fo. tr. and ho Man's Name. I: 75.

**S**aate. Sp. A Man's Name. II: 81.
Sadaki-dschajri La. Sadak's Little Lake. I: 507.

Sadak-kol. La. S's Lake. I: 209 ff., 454, 457, 461 ff., 466 ff., 473: II: 276, 298, 338, 348, 548, 576, 596.
Sadak-kul. La. II: 265.
Sadak-tu. Trb. II: 299.
Sadet-bekning-lämpasi. Fo. tr. Sadet Bek's Tomb. I: 53, 65.
Sadik-akin. La. S's Stream. I: 111.
Sadik-bajning-arighi. Old ca. S. Baj's Canal. I: 124, 125: II: 559, 590.
Sadik-on-kongen-dung. II: 505.
Safar-kasdi. The Cut Basket. II: 505.
Säfar-kasi. Desic. la. I: 429.
Sägislik. Vil. The Clayey Ground I: 69.
Sagislik. Fo. tr. I: 92.
Sägislik-kol. La. The Clay Lake. II: 194
Sägislik-kol. La. II: 211.
Sagislik-tscheke. Fo. tr. The Clayey Promontory. I: 141.
Sagislik-tscheke. Fo. tr. I: 145.
Sagis-tscheke. Fo. tr. The Clay Promontory. I: 144.
Sa-go. Dist. II: 474.
Sahara. Dst. II: 396 ff., 401 ff., 406, 412, 436, 459 ff.
Sait Bakini-kakbasi. La. I: 484.
Sait-satmasi. Fo. tr. S's Hut. I: 53.
Sait-tschapghan. Ca. S's Canal. I: 465.
Saj. The Gravel Plain. II: 132.
Saj-arik. St. The Canal of the Gravel Plain. I: 60.
Saj-bulak. Sp. The Spring of the Gravel Plain. II: 78.
Sajchen-ula Mt. II: 86.
Saj-kol. La. The Lake of the Gravel Plain. I: 43, 46.
Saj-lenger. St. The Station on the Gravel Plain. I: 67.
Sajram. Vil. II: 611.
Sajsan. La. II: 381.
Saj-tagh. Mt. The Gravel Mountain. I: 42 ff., 46 ff., 52, 131; II: 532.
Saj-tokkan Str. rg. Where the Eagle laid its Eggs. I: 192.
Saj-tscheke. Fo. tr. The Gravel Plain Bend. II: 10, 14, 18, 35.
Sakis-kulatsch-toghi. Dm. Eight Arms-lengths Dam. I: 511.
Sakitma. Ho. Where the Water formed Cataracts in olden Times. I: 499 ff., 504, 508; II: 561, 596.
Saldam. Vil. The Hunter's Outlook (in the branches of a tree). I: 118, 139.
Salim-soresu. Fo. tr. Sali's Hut. II: 10.
Sangelik. Vil. I: 9.
Sangir-urten. Vil. tr. II: 92 ff.
Sanguja. Vil. II: 604.
Sanija-satmasi. Fo. tr. I: 52.
San-sjan-tsi. Rge. II: 372 ff.
San-ta-ho. II: 444.
Sap-kojdi. La. The Laid Oar. I: 505, 507.
Sap-kojdi-kol. La. The Lake of the Laid Oar II: 513.
Sarat. Ma. The Burial-place. I: 63.
Sarati. Brl. pl. The Burial-place. I: 67.
Sarik-buja. Fo. tr. and ho. The Yellow Plant. I: 106 ff., 110; II: 599, 590.
Sarik-buka-oldi. Dist. Where the Yellow Bull Died. I: 61.
Sarik-kamisch. Msh. The Yellow Reeds. I: 100, 110; II: 293.
Sariklik Stp. The Yellow Place. II: 217.
Sarik-uja. In. The Yellow House. I: 390.
Sartang-nor. La. II: 285.
Sar-tokkan. Dist. Where the Bird of Prey laid its Eggs. II: 505
Sasik. Fo. tr. The Stinking. I: 65.
Sasik-jarsik. Sd. dn. The Stinking Lagoon. I: 69.
Sasik-kol. Msh. The Stinking Lake. I: 65.
Satak-tu. Trb. II: 279.
Sate-kol La. The Lake of S. II: 146 ff., 218, 246.
Satin-angesi. Str. rg. The Old Cultivated Fields of S I: 434.
Sati-salghan-modschuk. Cp. The Cape of Sati's Settlement. I: 281.
Sa-tscheo. Tn. II: 79, 85, 88, 104, 111, 113, 174 ff., 222, 271, 282 ff., 291 ff., 301, 307, 379, 382, 400, 471, 486, 493.
Sa-tschou. Tn. II: 79, 93, 98 ff.
Sattovaldi-kijik-atghan-dschaji. Rg. The Place where S. Shot the Buck. I: 187.
Sattovaldi-kol. La. S's Lake. I: 141, 187: II: 593.
Sava. Vil. II: 614.
Savat-asti. Fo. tr. The Suspended Basket. I: 50.
Schachtang. St. I: 67.
Schadang-kol. La. II: 513.
Schah-jar. Tn. The King's Terrace. I: 83, 88, 90 ff., 100 ff., 115, 144: II: 174, 279, 294, 307, 536, 539, 605 ff., 611.
Schah-jar-darja. Riv. The River of the King's Terrace. I: 99 ff., 112, 152, 155, 157; II: 525, 535 ff.
Schah-jar-darjasi. Riv. I: 109.
Schah Mansurne-osasene-basch-tam-arighi. Chl. The Canal of the Cultivated Land around Schah Mansur's Upper Clay House. I: 185.
Schah Mansurne-uji. Des. vil. S. M's House. I: 185.
Schah Mansurning-ötak-kolning-aghsi. La. The Mouth of the Lake Crossed by S. M. II: 511.
Schah Niasi-kadasi Str. rg. The Pole of Schah Nias. I: 182.
Schahr-i-katak-kum. Dst. The Desert of the Town of Katak. I: 40.
Schah Toktaning-kol. La. S. Tokta's Lake. I: 398.
Schakal-otak. Fo. tr. The Cotton Homestead. Schakal is properly the capsule of the cotton plant. I: 18 ff.: II: 558, 588.
Schaklik. Fo. tr. The Tract of Branches. I: 92.
Schakurun. Crt. Waterfall. I: 23.
Schaldran. Gn. The Echo in the Mountains. II: 80.
Schaldrang. II: 77.
Schaldschalik. Fo. tr. Where Ticks are Found. II: 10.
Schamal. St. The Windy. I: 39: II: 531.
Schamal-gansin-kum. Dst. II: 389.
Schamal-kirtschin. Fo. tr. The Windy Forest Tract. I: 103.
Schama-tschapghan. La. S's Canal. I: 432.

Schambuluk. The Place of the Tall, Thin Poplar Stem. I: 89.
Schan-si. Prov. II: 382.
Schan-tung. Prov. II: 333.
Schaptik-kol. La. The Lake of the Schap (a yellow plant of which camels are very fond). II: 144.
Schaptul-koli. Str. rg. The Apricot Lake. I: 398.
Schare-chalesun. Dist. The Yellow Kamisch. II: 55.
Schare-ghadser. Pa. gr. The Yellow Tract. II: 22.
Scharkurama. Chl. The Waterfall. II: 136.
Scharkurun. Crt. The Cataract Arm. I: 180. 183.
Scharkurun. Str. rg. I: 220.
Scharkurun. La. I: 432.
Scharkurun. Crt. I: 486 ff., 497; II: 561.
Schaschkak. Fo. tr. I: 17; II: 469, 529. 553. 558, 588.
Schat-el-Arab. Riv. I: 155.
Schejklerning-tamlari. Vil. The Sheiks' Huts. I: 83.
Schejtdake-uj. Pl. The Scheits House. I: 421.
Schejtlar. Vil. The Scheits, because a Masar is situated in the neighbourhood. I: 192. 379, 486 ff., 500.
Schejtler. Vil. The Scheits I: 421, 422; II: 596.
Schejtlerni-osasi. Dist. The Ploughed Fields of the Scheits. I: 421
Schejtlik. Fo. tr. The Scheit Place I: 18.
Schen-si. Prov. II: 380, 382. 441.
Schiadeki-dung. Hl. Schia's Hill. I: 503.
Schidak-mahallasi. Fo. tr. S's Village. I: 182.
Schi-da-sen. Mt. The Great Stone Mountains. II: 37
Schi-dun-tse. Stp. II: 371.
Schikak. Ca. Hunting. I: 185; II: 511.
Schikak-kol. La. The Lake where one lies in Wait (for Fish). I: 185.
Schikak-kol. La. I: 297. 299. 307; II: 511.
Schi-lang-to. Sp. II: 471.
Schinalgha. Vil. I: 427; II: 5. 17, 604.
Schinnegha. Vil. II: 17.
Schirdake-attasi-avul-tschapghan Po. The Canal first Dug by Schirdak's Father. I: 481.
Schirdak-uji. Fo. tr. S's House. II: 11.
Schirge-tschapghan. Riv. & vil. S's Canal. I: 214 ff., 222, 260. 300. 404. 406, 408. 437. 440 ff., 450 ff., 453 ff., 463. 475. 487. 490 ff., 497; II: 128. 130, 140. 152 ff., 161, 167 ff., 191, 209 ff., 272 ff., 299, 302, 339, 354, 363, 548, 550 ff, 560 ff, 579, 592 ff.
Schor-bulak. St. The Salt Spring. II: 37 ff.
Schor-bulak. Sp. II: 89, 88.
Schor-kasch. Fo. tr. The Salt Terrace. I: 83.
Schor-kol. La. The Salt Lake. I: 34 ff, 39
Schor-kol. Fo. tr. I: 89.
Schor-kol. Old la. I: 385.
Schor-kol La. II: 393.
Schor-kol. La. II: 531.
Schorluk-utak. Fo. tr. The Dwelling-Place of the Salt Marsh. I: 34.
Schor-sulak. Str. rg. The Salt Drinking-Place or the Salt Marsh. I: 398.
Schor-tegisch. Fo. tr. Where the Road touches the Salt Ground. I: 103
Schor-tschokti. Vil. (Misprint for Schor-tschakti); The Eroded Salt Bank. I: 83.
Schudang. Pl. & st. Thick, High Poplar Forest. I: 375 ff.
Schukurne-koli. La. The Benediction Lake. I: 187, 220.
Schukurning-kolning-koschluschi. Con. The Confluence of the Benediction Lake. II: 512.
Schupurluk. Sa. The Place of Schupur (skin of apple, apricots and other fruits). I: 73. 80.
Schupurluk. La. I: 110.
Sejt-Asarni-ilegi. La. The River-arm of S. Asar. I: 432.
Seit-kol. La. The Seit's Lake. I: 150 ff., 229 ff., 255, 276, 298. 304. 314; II: 335.
Seit-uj. Chl. The Seit's Village. I: 209; II: 560.
Seit-uji. Ht. I: 124. 223.
Selimi-tschojogho-kol. La. I: 182.
Semilaku-kol. La. The Lake of the Fat Fish. I: 219, 222 ff.; II: 198.
Semilaku-tekgen. Str. rg. Where the Fat Fish Touched (the net). I: 221.
Sensulu. Sp. II: 77.
Seri-tu. Sp. II: 77.
Serteng-nur. La. II: 285.
Setemse-bulak. Sp. S's Spring. II: 78.
Sha-chau. Tn. II: 260. 266.
Shan-shan. Ctry. II: 301.
Shen-shen. Kdm. II: 260. 283.
Siao-tschao. II: 382.
Si-dun. Wl. II: 372. 375.
Siksan-bulak. Sp. The Eighty Springs. II: 78.
Siksan-kotak. Dist. The Eighty Woods. I: 106.
Sil. Dist. The Inundation. I: 80.
Similanu-Dschan-bulaghi. Sp. The Spring of S. D. II: 471. 472.
Simlik. Ho. The Cake of Turf. I: 104; II: 604
Sinbir. Mt. ra. II: 91 ff.
Sindan. The Prison. II: 77.
Singer. Vil. The Heel. II: 4. 22, 25 ff., 35, 37 ff., 55. 79 ff., 92, 232.
Singer-ortang. St. The Station of Singer II: 92.
Singim. II: 92.
Sin-mahalla. Vil. I: 175.
Si-ning. Tn. I: 399.
Sinir. Mt. ra. The Heel. II: 97.
Sin-sen-schi. II: 38.
Sir-darja. Riv. I: 191; II: 444. 448, 522, 528.
Sirikul. Rg. II: 611.
Sitmet-kojghan-kemi. The Ferry where S. was left. II: 505.
Siva. Fo. tr. Tall, Thin Poplars. I: 141, 142; II: 559. 590.
Siva-kotan. Fo. tr. The Hut of the Tall Poplars. I: 48.
Soda-Lake La II: 397.
Soghot. Bol. I: 205. 433. 477 ff., 493; II: 298 ff., 311.
Soghujtschagh-jatghan-kotan. (S. is a vessel hollowed out from a poplar trunk); the Hut where the Wooden Vessel lies. I: 432.
Soku-jangal. Sp. The Oblong Forest. II: 77.
Sokuschghan Str. rg. The Place of Scolding. I: 214.

Sollak-aghis. The Mouth of the Stagnant Water. II: 77.
Sollak-akin. Old riv. bd. The Stagnant or Arrested Current. I: 477, 478.
Sollak-darja. Old riv. The River without Beginning or End, i. e. isolated. cut off river-arm. I: 398, 400.
Soloma. Old la. A bulungs or Bay of a Lake: in connection with the lake, but a cul-de-sac. II: 150, 156.
Solomadake-dung. Hl. The Hill of the Bay. I: 190.
Sopu-dughan-koli. La. The Lake of S. D. I: 419.
Sopu Nias. Fo. tr. Man's Name. II: 10.
Sora-tökorgen-kol. La. II: 513.
Sor-kol. La. The Big Lake. II: 215.
Sor-sure. Fo. tr. The Big Hut. I: 103; II: 555, 567, 569, 589.
Soru. Pl. The Hut. I: 426.
Sorun. Vil. The Fresh. Agreable Place. I: 52, 68; II: 554, 558, 589.
Sorun-ajaghi-kol. La. The Lower Lake Sorun. I: 43.
Sorun-kol. La. The Lake of the Fresh Place. I: 40 ff., 64, 66.
Sorun-kol. La. II: 303, 470, 531.
Sougout koul. La. II: 310.
Sourghak-darja. Stm. II: 522.
Suan-chua-fu. Tn. II: 380.
Subuntschi-därvase. Gt. The Gate of S. I: 67.
Suget. Vil. The Willow. I: 36, 58, 66, 67.
Suget-bulak. Gn & sp. The Willow Spring. II: 11, 16 ff., 21 ff., 38, 79, 95 ff., 466, 524.
Sugetlik. Str. rg. The Willow Tract. I: 80.
Suget-tokaj. Fo. tr. The Willow Forest. I: 58.
Suji-sarik-kol. La. The Yellow Water Lake; because great parts of it are without vegetation and the bottom looks yellow owing to the sand. I: 484 ff., 494; II: 342, 347, 576.
Suji-sariktake-uj. Ho. The Village of the Yellow Water. I: 484.
Su-la-ho. Riv. II: 407, 444.
Su-lai. Riv. II: 372.
Su-lai-khe. Riv. II: 372, 374.
Sulej-che. Riv. II: 174.
Su-lo. Riv. II: 287.
Sultan Ali Katta Busrugvar. Ma. A Saint's Name. I: 83.
Sultan Hakim Attam Busrugvar. Ma. A Saint's Name. I: 103.
Sultan Kara Sakal Attam. Mt. A Saint's Name. I: 41, 47, 64 ff.
Sultan Kokmet Attam Busrugvar. Ma. A Saint's Name. I: 102.
Sultan Muhamed Attam Busrugvar. Ma. A Saint's Name. I: 100.
Sultan No Aravattam Busrugvar. Ma. A Saint's Name. I: 105.
Suluthu. Riv. II: 287, 291.
Su-osgen. Fo. tr. The Growing Water. I: 383, 389.
Supa-Bek-otgen-togh. Dm. The Dam on which S. B. Crossed over. I: 169.
Sopa-dughan-uji. Des. ho. S. D's House. I: 192.
Supa-dung. Stp. S's Hill. I: 383.
Supurlak-darja. Riv. I: 118.
Susuk. Pl. The Clean (Transparent). I: 113, 115 ff.
Susu-kok-alasi. Ca. The Clear (clean) River-Branch. I: 174, 287.
Susuk-kol. La. The Transparent Lake. I: 66, 181, 506 ff.; II: 513.
Susuk-mahalla. Vil. The Clean Village. II: 513.
Su-tscheo. Tn. II: 371, 373, 380.
Su-tschou. Tn. II: 98.
Suvurghu-mus-kadaghan-kol. Old la. The Lake where S. Hung up the Horn. I: 420.

Tadlak-bulak. Sp. The Freshwater Spring. II: 472.
Tadschini-ottogho. Str. rg. The Tadschik's Dwelling-Place. I: 224.
Tadschinur-nor. La. II: 370.
Taghar-aghisi. Str. rg The Mouth of the Sack. I: 80.
Tagh-kum. Sd. The Mountain Sand. I: 380, 406 ff., 415, 459; II: 222, 338 ff.
Tagirmän. Vil. The Mill. I: 421.
Tagirman. Vil. I: 486 ff., 503, 505; II: 561.
Tagirman. Vil. I: 436; II: 5.
Tagirman-arighi. Riv. br. The Mill Canal. I: 168.
Tägirman-baschi. Stp. The Beginning of the Mills. I: 382, 383.
Tagirmandake-uj. Des. vil. The Mill Village. I: 179.
Tagirmän-taschi. Dist. The Mill Stone. II: 78.
Ta Gobi. Dst. The Great Desert. II: 282.
Tais-kol. La. The Shallow Lake. I: 289, 294 ff., 508.
Tais-kol. La. II: 147.
Tajek-kol. La. T's Lake. I: 304, 472, 480 ff., 492, 494; II: 222, 298, 304 ff., 311, 331, 340 ff., 348, 392, 580, 581.
Tajek Pavane-joleg-ottogho. Bol I: 206.
Tajir Achune-kotane. Ht. T. Achun's Hut. I: 185.
Tajir-bajning-kotan. Fo. tr. The Hut of T. Baj. I: 126.
Tajiri-kakmasi. La. The Bay of Tajir. I: 168, 277, 279, 285, 298, 306.
Tajir-jajiri. La. The Little Lake of T. I: 432.
Tajir-kirgen. La. Where T. Settled down (for fishing). I: 492.
Tajir-tschapghan. Str. rg. T's Canal. I: 493.
Tajlak-tutghan. Pl. Where the Young Camel was Caught. I: 372.
Tak. Vil. II: 611.
Takija-tagh. Mt. ch. The Pillow-shaped Mountain. II: 175, 283.
Takkan. Dst. I: 40.
Takkum. See Tagh-kum.
Takla-makan. Dst. I: 40, 47, 62, 87, 161, 234, 243, 392, 311, 316, 323, 327, 339, 364, 374, 512; II: 112, 221, 370, 379, 382 ff., 390, 396 ff., 401, 408, 435 ff., 447, 452 ff., 464 ff., 480, 525, 530.
Takta-pere. Sa. I: 395, 398.
Talaj-jatghan-tarim. Riv. The River of T's Grave. II: 512.

Tala-kol. La. The Desert Lake. I: 62, 71.
Talaschti. La. The Place of Dispute. I: 180.
Talaschti. Dist. I: 405.
Talaschtik-mughu. La. The Disputed Eleagnus-Berries. I: 432.
Talaschtu-kok-alasi. Ca. The Disputed River-Arm. I: 297.
Talaschtu-kol. La. The Disputed Lake. I: 187, 287, 289, 297, 299, 306, 508; II: 510.
Talaschtu-kol-aghsi. The Mouth of the Disputed Lake. II: 510.
Tala-tschorak. Str. rg. The Broad Isolated Water; tala is generally a broad open place; tschorak is a part of a lake, that is cut off, without affluent or emissary. I: 102.
Tala-tschorok. Dist. I: 410.
Talei Kullune-koli. La. T. Kullu's Lake. I: 287, 289.
Talei Kullunu-kotschetu. Ho. The Descendant of T. Kullu. I: 168.
Talei Kullu-tschapghan. La. The Canal of T. K. I: 232, 298, 306.
Talei Kullu-tschapghan-kol. La. The Lake of T. K's Canal. I: 101.
Tale-jatghan-tarim. Old riv. bd. The River where T. is Resting. I: 188, 190.
Talipi-egrimi. Str. rg. The River-loops of T. I: 102.
Tal-kejtschin. La. See Tal-kirtschin. II: 208.
Tal-kirtschin. Str. rg. The Willow Forest. I: 463, II: 560.
Tal-kirtschin-tscheke. The Promontory of the Willow Forest. II: 504.
Tal-kitschin. La. II: 208, 311,
Tallik. Str. rg. The Willow Forest. I: 434.
Tallik. II: 38.
Tallik. II: 77.
Tallik-tokaj. Fo. tr. The Willow Forest. I: 382.
Tallik-tokajning-ajaghi-kol. La. The Lake of the Lower End of the Willow Forest. I: 140.
Tallik-tokajning-kum. Sd. The Desert of the Willow Forest. I: 382.
Talluk-bulung. Fo. tr. & ho. The Bay with the Willows. I: 102.
Ta Lob-nor. La. II: 311, 312.
Talpak. Fo. tr. The Cap. I: 94; II: 555, 580.
Tal-satma. Fo. tr. The Willow Hut. I: 63.
Taltikti-koli. La. The Freshwater Lake. I: 187.
Taman-aktik-kol. Bol. The Water-lily Lake. I: 209.
Tamirlik. Sp. The Iron Place. II: 586.
Tamir Niasne-uji. Vil. T. Nias' House. I: 102.
Tam-uj. Ht. The Clay House. II: 505.
Tana-baghladi. La. The Lake Dammed by Tana; tana is also a thin rope. I: 298, 312 ff., 318; II: 573.
Tana-baghladi-kol. La. The Lake Closed by T. I: 161, 232, 264 ff., 305, 311; II: 572.
Tana-baghlaghan. Dist. Closed by T.: or the Tied Rope, as a token that the fishing is here monopolised. I: 415; II: 341.
Tangsok-tagirman-kok-alasi. Chl. The River arm with T's Mill. I: 506.
Tan-ho. Riv. II: 222.
Tao-tung-tsa. Vil II: 380.
Tapan-san. Mt. ra II: 380.
Ta-pan-shan. Mt. II: 395.
Tapeldini-koli. Old la. Tapeldi's Lake. I: 420.
Tapsi. Fo. tr. Shelf, i e. Terrace. I: 55, 59.
Tapsi-kol. Old lp. The Shelved Lake: the Shore-like Terraces. I: 55.
Taraschah. Fo. tr. A Man's Name. I: 102.
Tarascha-kotan. Str. rg. The Hut of T. I: 435 ff.: II: 505.
Taraschi. Pl. A Man's Name, or poles for the walls of a house. I: 111, 113.
Tarbus-jeghan-dung. The Hill where the Melon was Eaten. II: 505
Tarim. Riv. The River. I: 3, 10 ff., 21, 28, 38, 70 512: II: 6 ff., 30, 43, 49 ff., 125 ff., 146 ff., 200 ff., 300 ff., 503 ff., 559 ff., 595, 568, 570 ff., 578 ff., 587 ff., 592 ff., 606 ff., 623.
Tarim-basin and Tarim-depression. II: 565 ff.
Tarim-kirdi. Str. rg. Where the River Dug out (i. e. a new bed on the side of the old one). I: 179.
Tarimning-koschluschi-Chodscham Kaldining-tagirmani. Ml. The Mill of C. Kaldi at the Confluence of the River. II: 513.
Tarim-nor. La. The Tarim Lake. II: 297.
Tarim-tuschken-kol. La. The Lake of the Discharging River. I: 408.
Tarischi-sindi-kol. II: 505.
Tarka. Sp. The Narrow Place. II: 37.
Tar-kum. Sd. The Narrow Sand. I: 379, 380.
Tartang. Wl. I: 333.
Tarym. Riv. II: 455.
Tasch-kitschik. Str. rg. The Little Stony Place. I: 348.
Tasch-kol. La. The Stone Lake. II: 471 ff.
Taschlap-katgen-uj. The Abandoned House II: 505.
Taschtane-koli. La. Taschtan's Lake. I: 483.
Taschtan Kullu. Dist. Man's Name. I: 404, 405.
Taschtan Kullune-kakmasi. Bay. The Bay of T. K. I: 289.
Tasch-tschukan. Dist. The Sunk Stone. I: 430.
Tasch-ua. Ps. The Stone Obo. II: 79.
Tasghun. Dist. & vil. The Great Canal. I: 7.
Tataktik-kir. Dist. The Hill with Reed Roots. I: 147.
Tatir-ilek. Riv. br. The Deserted River; tatir is generally hard, even, barren clay-ground. II: 512.
Tatlik-bulak. Sp. The Fresh Spring. I: 308; II: 37, 77, 87, 148, 176, 471 ff., 583.
Tatlik-jigde. Fo. tr. The Sweet Eleagnus I: 26.
Tatlik-kuduk. Wl. The Sweet Well. II: 576.
Tatlik-mejsen-arighi. Ca. The Canal of T. M. I: 114.
Tatran. Vil. I: 270, 311 ff., 333, 349, 369, 383 ff.; II: 217, 307, 435, 438, 459.
Tauschkan-darja. Vl. The Hare River. II: 97, 521, 523, 525 ff., 566.
Tavak-kaldi. Fo. tr. The Wooden Vessel was Left. I: 84.

Tayek koul. La. T's Lake. II: 310.
Tayek-kul. Bsn. See Tajek-kol. II: 265.
Tchertchen-daria. Riv. II: 310.
Tegerik. II: 285.
Teis-kol. La. The Shallow Lake. I: 150 ff., 228 ff., 298, 307; II: 500. 556. 590.
Telejmet-kobrugi. Br. The Bridge of T. I: 67.
Telep-köli. La. II: 505.
Telve. Vil. I: 71.
Temen-ghaschon. La. The Lower Salt Lake. II: 292.
Temmenai-khuduk. Wl. The Well of the Camel's Sleep. II: 292.
Tengelik. Rg. II: 285.
Tengeri. Dst. II: 380, 381.
Tenger Kullune-uji. La. T. Kullu's House. I: 432.
Tepe-teschdi. Fo. tr. The Hollow Hill; or the Hill with the Hole. I: 61.
Terem. Vil. The Cultivated Fields. I: 7 ff.
Terem. Riv. I: 102, 121.
Terema-köli. La. The Fish-skin Lake. II: 194.
Teres. Fd. I: 101; II: 555, 559.
Terimi-modschughu. Cp. The Cape of the Cultivated Fields. I: 270.
Terimi-modschuk. Cp. I: 281.
Terke-terken. Dst. I: 71.
Terskej. Mts. II: 97.
Teschik-bulak. Sp. The Hollow Spring. II: 63, 75, 82 ff., 91.
Teschme-kotak. Str. rg. The Hollow Dry Wood. I: 96.
Tes-jatghan. Where the White Horse lies. II: 217.
Teven-tagh. Mt. The Lower Mountain. I: 41.
Tha-li-mu-tschi. La. II: 288.
Tho-mon-nai-hu-tu-k'o. Wl. II: 292.
Thsao-hu. La. The Grass Lake. II: 289.
Tian Shan. Mts. II: 97.
Tibet. Ctry. I: 74, 79, 86, 145, 150, 269; II: 92, 147, 269 ff., 313, 340, 370, 382, 389, 420, 475, 521 ff., 528, 566, 586.
Tien-schan. Mts. I: 4, 77, 100, 102, 107; II: 94, 97 ff., 293, 340, 381 ff., 392, 516, 523 ff., 565.
Tikenlik. Vil. The Lycium Tract. I: 176, 183, 288, 302, 428 ff., 506 ff.; II: 52, 135, 264, 333, 355, 503, 505, 512, 519, 520, 596.
Tikenlik. Dist. I: 432, 478 ff., 499.
Tikenlik-dschaji. Ho. The Place of the Lycium Tract. I: 511.
Tinakul-bekning-kum. Dst. The Desert of T. Bek. I: 398.
Tinatschini-kolidake-osasi. Fld. The Field of the Lake Abounding in Small Fish. I: 190.
Tinatschini-kotormesu. Str. rg. The Portage of the Small Aboundant Fish. I: 191.
Tjan-schan. Mt. ra. II: 381, 382.
Tjinalga. Vil. II: 93.
Tjong-altin-tag. Mt. The Great Gold Mountain. II: 93.
Tobve. Ps. II: 22.
Toghluk. Dm. The Dam Place. II: 588.
Toghoro-darja. La. The Straight River. I: 433, 434.
Toghrak-aghil. Stp. The Shepherd's Camp amongst the Poplars. I: 382.
Toghrak-aghil. Str. rg. I: 398.
Toghrak-bulak. Sp. The Poplar Spring. II: 23, 24.
Toghrak-bulak. II: 35.
Toghrak-bulak. II: 37 ff., 53.
Toghrak-bulak. Sp. II: 78.
Toghrak-bulak. Sp. II: 80.
Toghrak-bulak. Os. II: 104 ff., 113, 118, 174, 284, 468, 471, 496 ff., 499.
Toghrak-bulak. Sp. II: 471.
Toghrak-kuduk. Wl. The Poplar Well. II: 579.
Toghraklik-eger-asti. Fo. The Poplar Grove where the Saddle was Hung. II: 511.
Toghraklik-kol. La. The Poplar Lake. I: 252, 265 ff., 275, 298, 307.
Toghraklik-kol. La. I: 450.
Toghraklik-kol. La. The Poplar Lake. I: 115.
Toghraklik-kolning-daschi. Ba. with po. The Salt-pools of the Poplar Lake. I: 265; II: 506.
Toghraklik-tokaj. Fo. tr. The Poplar Forest. II: 471.
Toghrak-mahalla. St. The Poplar Village. I: 117.
Toghrak-modschughu. Cp. The Poplar Cape. I: 281.
Toghrak-modschuk. Ppr gr. The Poplar Cape. I: 251.
Toghrak-tschap. Gn. The Poplar Ravin. II: 217.
Toghrak-tscheke. Fo. tr. The Poplar Bend. I: 470.
Toghri. Fo. tr. The Straight. I: 65; II: 580.
Toghri-darja. Fo. tr. The Straight River. II: 10.
Toghri-jangal. Fo. tr. The Straight Forest. I: 387.
Toghri-kol. La. The Straight Lake. I: 507; II: 11.
Toghri-kum. Sd. The Straight Sand. I: 51 ff., 69, 532, 554, 558.
Tojaghun. La. II: 139 ff., 146
Toj-bolghan. La. The Lake where the Wedding was Celebrated. I: 432.
Tokaleschti-mandscharighi. La. I: 477.
Tokkum-kul. La. The Lake of the Pack Saddle; a very winding river is also called Tokkum-darja. II: 298.
Tokoum koul. La. II: 310.
Toksun. Vil. II: 87, 94, 98.
Tokta Chodscha-tagirman-kok-alasi. Chl. The River-arm of T. C's Mill. I: 506.
Toktaghone-kolo. La. The Lake of T. I: 484.
Toktaghono-mandscharlighi. Str. rg. I: 288, 206.
Toktak. Pl. I: 375.
Toktaka. Vil. I: 7.
Tokta Kullune-koli. Fo. tr. The Lake of T. Kullu. I: 210; II: 569.
Tokta Niase-modschughu. Cp. The Cape of T. Nias. I: 251.
Tokta Niasi-modschuk. Cp. The Cape of T. Nias. I: 281.
Tokta Niasne-modschughu. Prm. The Cape of T. N. I: 255, 282.
Toktasin Bek. Ar. Man's Name. I: 216.
Tokum. St. hs. The Pack Saddle. I: 210, 404, 406, 412; II: 504.
Tokum-kol. La. The Lake of the Pack Saddle. II: 298, 311.

Tokum-kul. La. II: 302.
Tokum-tuschkun. Lp. The Camping-ground of the Pack-Saddle I: 210.
Tokus-attam. Vil. The Nine Fathers. I: 218 ff., II: 593.
Tokus-davan. Mts. The Nine Passes. I: 342, 348, 383.
Tokusi-kok-alasi. Dist. The Nine River-arms. I: 414.
Tokus-kol La. The Nine Lakes. I: 381.
Tokus-kum. Sd. The Nine Sands. I: 128, 130 ff., 145, 166, 380; II: 538, 556, 590.
Tokus-tarim. Riv. The Nine Rivers. I: 222, 446, 450, 455 ff., 463, 497; II: 128 ff., 140, 161, 167, 169, 182, 184, 193, 208 ff., 228, 250, 274, 302, 339, 355, 362 ff., 550 ff., 560, 561, 593 ff., 596.
Tokus-tolluk. Fo. tr. The Nine River-Loops. II: 10.
Tolan-chodscha. Riv. II: 348, 522 ff.
Tolanda. Fo. tr. Indemnification for lost goods; pledge; also a man's name. I: 24; II: 558, 588.
Tolan-kemisi. Fo. tr. The Filled Canoe. I: 83, 87.
Tolan-kobrugi. Vil. Br. The Laden Bridge. I: 71.
Tolan ostang. St. The Filled Canal. I: 67.
Toli. La. II: 118, 121, 173, 286.
Tollak Kullu. St. A Man's Name. II: 217.
Tollan-chodscha. Riv. I: 373, 375, 379 ff.
Tollogóning-uktusi. La. The Little Lake of Tollogon. II: 505.
Tollondoni-köli. La. I: 482.
Tòlogon-tareghan. Dist. T. has been Sowing. I: 430.
Tologon-tareghan-baschi. Str. rg. The Upper part of T's Fields. I: 430.
Tolotto-ottogho. Dist. T's Dwelling Place. I: 177.
Tomanki-arelisch. Con. The Lower Confluence. I: 137.
Tomànki-jardang-bulak. Sp. The Lower Terrace Spring. II: 54.
Tomàn-tagh. Mt. The Lower Mountain. I: 65 ff.
Toman-tagh-köli. La. The Lake of the Lower Mountain. I: 66.
Tomen-akin. Ca. The Lower Current. II: 510.
Tomen-ghaschon. La. The Lower Salt Lake. II: 292, 297.
Tomur Bekning-ghaghal-tasi. Dist. I: 502.
Tomur-kose. Sd. hl. The Iron-peg. I: 429.
Tong. The Frozen, Hard. Vil. II: 450, 516.
Tongus-atti-kol. La. The Lake of the Shot Boar. I: 120.
Tongus-burun. Fo. tr. The Boar's Nose. I: 55.
Tongus-jardi. La. Where the Boar Tore (the sack with the Eleagnus-berries). I: 432.
Tonguslik. Fo. tr. The Tract of the Boars. I: 14; II: 86.
Tongusluk. Dist. The Tract of the Boars. I: 435 ff.
Tongus-oldi. Fo. tr. Where the Boar Died. I: 18.
Topa-kaschte. Fo. tr. The Earthen Terrace: is said to be a corruption of Torpak-katschti or the Run away Calf. I: 89; II: 535.
Topalang. Fo. tr. The Earthen Place. I: 61.
Topluk. Vil. The Cannon Place. I: 71.
Top-toghrak. Fo. tr. The Cannon Poplar. I: 82.
To-pu-kou. St. II: 278.
Torak-bulak. Sp. The Poplar Spring. II: 80.
Torpak-oldi. La. The Calf Died. I: 287, 299, 307; II: 506 ff.
Toruk-jangal. The Round, Isolated Forest Tract. II: 77.
Toschkan-darja. Riv. The Hare River. I: 78, 125.
Toschkan-salghan. Dist. Where the Hare was laid down. I: 430.
Toschkan-tscholi. Fo. tr. The Little Hare Lake. I: 27.
Tosghak-tschantschdi. Vil. The Sedge Stalk Stuck in the Ground; tosghak is the seed-pod of the jakan; tschantschdi = driven into the bottom or ground as a token that the fishing is monopolised. I: 416, 477 ff., 479, 481, 483, 486, 492; II: 299, 596.
Tottor-akin. Ca. The Current of the Desert Steppe. I: 110.
Tottor-kotan. Dist. The Hut of the Desert Steppe. I: 113.
Tottoru. Ca. The Deserted Region; or in some places the Forest situated on the peninsula of a river-loop. I: 144.
Tottoru. Dist. I: 431.
Tottoru-jaghatsch. Dn. & Fst. The Wood of the Deserted Region. I: 141; II: 539.
Transcaspia. Prov II: 68, 388, 396, 405.
Tsagan-ula. Mt. The White Mountain. II: 473.
Tsaghan-tschilaotu. St. The White Stone. II: 278, 285 ff.
Tsajdam. Bsn. II: 54, 218, 278 ff., 295, 369 ff., 524, 574.
Tschadir. Vil. The Tent. II: 293, 307.
Tschadir-kol. Vil. The Tent Lake. I: 36, 38, 40, 66 ff., 51, 65, 67.
Tschadir-tagh. Mt. The Mountain of the Tent. I: 66.
Tschahr-bagh. Vil. The Four Gardens. I: 36, 38, 40, 66 ff.
Tschahrlik-kol. La. The Four Lakes. I: 67.
Tschaj. Vil T. is a sort of grass, that cattle are fond of. I: 218, 221, 463.
Tscha-jan. Riv. I: 100 ff., 118, 128, 151, 155.
Tschajatik-kol. La. A sieve-like box to keep the net in after fishing. II: 215.
Tschajlik. Fo. tr. The Pasture-Ground. I: 58, 192; II: 10.
Tschajnot-kol. La. II: 194, 195, 196, 199.
Tschakan. Fo. tr. I: 73.
Tschakirni-aghsi. La. The Mouth of the Wine. II: 194.
Tschako-tschapghan. Ar. The Canal of T. I: 217.
Tschakullalik. Str. rg. The Tract of the Terns. I: 224.
Tschalak. Fo. tr. The Barrel. I: 98.
Tschaltschik. Pl. A Trickling Fountain. Water forming marshes and pools. I: 379.
Tschanga-kol. La. The Lake of the Eagle Nest. I: 111.
Tschang-an'i. Tn. II: 264.
Tschangelik. The Place of the Claw (?). II: 513.
Tschangel-saldi-kol. La. II: 513.

Tschangumalak-kol. La. II: 513.
Tschapa-kol. La. The Lake of the Sewing-cotton. I: 507.
Tschapal. Fo. tr. T. is synonymous with ala-kum; i. e. sporadic sand amongst steppe or forest. I: 427, 429, 502, 505; II: 11.
Tschapan-kaldi. St. The Coat was Left. II: 403, 465, 466.
Tschapghan-kol. La. The Dug-out Lake. I: 190.
Tschapgan-kol. I: 287, 297, 299, 307, 508.
Tschapghan-kol. Dist. The Lake caused by a Dug Canal. I: 416.
Tschapghan-kol. Fo. tr. II: 10.
Tschapghan-kol. La. II: 509, 510.
Tschapghan-kol. La (No. 2). II: 512.
Tschaptschimal. Fo. tr. T. is a shallow inundated region, where however the fish can pass over from one lake to another. I: 419.
Tschaptschimal-kok-alasi. Riv. The Shallow, Broad River-arm. I: 192.
Tschara. Vil. I: 508.
Tscharajlik-tagh. Mt. The Beautiful Mountain. II: 86, 89, 91.
Tschark-asti. La. The Suspended Wheel. I: 110.
Tschark-asti-kol. La. The Lake of the Suspended Wheel. I: 107, 109 ff.; II: 536.
Tscharklik. Tn. The Wheel Place. I: 218, 220 ff., 224, 370, 385, 391, 397 ff., 403, 449, 457, 461, 466, 477, 479, 509 ff.; II: 5, 132, 140, 148, 152, 216 ff., 301, 425, 503 ff., 512, 570, 586, 592, 608.
Tscharklikning-su. Riv. The Water of the Wheel Place. I: 398.
Tscharklik-su. Riv. The Water of the Wheel Place. II: 217, 504, 522, 570, 571.
Tschartma-kotan. Ht. A hut built of Poles Driven vertically into the ground and of branches. I: 419.
Tschartschak. Rge. The Mountain of the Wearied Ones. II: 52.
Tscharuk-asti. Fo. tr. The Suspended Shoe. II: 10.
Tscharvalik. Dist. The Region of Cattle. I: 434.
Tschaval-dung. Stp. The Hills with Scattered Poplars; or simply: The Scattered Hills. I: 382.
Tschaval-kum; the Desert with Scattered Poplars (at the lower Tschertschen-darja; not in the Text).
Tschege-jejnek. Fo. tr. The Asclepias Loop. I: 98.
Tschegelik-uj. Vil. The Asclepias Village. I: 113, 158.
Tscheke-jinek. The Loop with the Promontory. II: 513.
Tschelija-tagh. Mt. I: 66.
Tschen-tschang. II: 37.
Tscherek-tuschken-tscheke. Fo. tr. The Promontory where the Soldiers Encamped. II: 513.
Tscherik. Ho. The Soldiers' Place. I: 423.
Tschertschen. Tn. I: 230, 233, 348, 351, 369 ff., 381 ff.; II: 35, 218, 279, 296, 301, 309, 353 ff., 382, 525, 570, 599, 605.
Tschertschen. Prov I: 370.
Tschertschen. Dst. II: 348, 349, 355, 379, 383, 396, 397, 399—404, 408, 409, 414, 415, 417, 426, 434—436, 438—441, 451, 452, 458, 460, 462, 463, 466, 467, 479—481, 485, 571 f., 578 ff.
Tschertschen. Os. II: 525.
Tschertschen-darja. Riv. I: 79, 215, 221 ff., 302, 311 ff., 328 ff., 340, 345 ff., 371, 380 ff., 390 ff., 400 ff., 412, 419; II: 8, 153, 169, 174, 198, 211, 221, 262 ff., 279, 299, 302, 307 ff., 333 ff., 358, 370, 387, 392, 462 ff., 504, 515, 518 ff., 545, 551, 560, 571, 578, 606.
Tschertschen Desert. Dst. I: 162, 188, 243 ff., 253, 328, 353 ff., 361 ff., 406 ff., 438, 490; II: 198, 220 ff., 333 ff., 341 ff., 355, 379, 383, 396 ff., 400 ff., 414 ff., 429, 434 ff., 451 ff., 485 ff., 579.
Tschi-dao-gou. Fts. II: 372.
Tschigan-tschon. Vil. I: 66.
Tschige-bulak. Gn. & Sp. The Asclepias Spring II: 18.
Tschigelik. Vil. The Asclepias Region. I: 174, 429, 431; II: 272.
Tschigelik-kuduk. Wl. The Asclepias Weg. II: 113.
Tschigelik-uj. Vil. The Asclepias Village. I: 200, 217 ff., 402 ff., 449 ff., 457; II: 43, 139, 200, 215, 224, 258, 272, 275, 302, 333, 345, 355, 445, 560, 574, 580, 592 f., 604.
Tschige-tugh. Vil. The Asclepias Dam. I: 4.
Tschighanlik. Old riv. br. I: 115.
Tschighan-tschol. Vil. I: 36, 65 ff.
Tschi-jo-khe. Riv. a. II: 373.
Tschilan. St. & vil. A kind of berries. I: 59, 67.
Tschimalelik. Dist. The Ant-Region. I: 213.
Tschimen. Dist. The Grazing. I: 94 ff.; II: 217 ff., 307, 449, 518, 570, 589.
Tschimen. Vl. II: 281.
Tschimen-kol. La. The Grazing Lake. II: 281.
Tschiminlik. La. The Lake with Grazing. II: 298, 311.
Tschinagh-jatghan-tschol. St. rg. The Little Lake where T. is Sleeping. I: 434.
Tschindejlik. Wl. II: 174 ff., 579.
Tschingelik. Fo. tr. & ho. A kind of plant. I: 103.
Tschingelik. Wl. I: 375.
Tschin-schen-khe. La. II: 372, 373.
Tschin-schen-ho. La. II: 371.
Tschira. Tn. II: 605, 611.
Tschirak-tschantschghan. Str. rg. The Candle set up or the Candle put down on the ground. I: 223.
Tschirik-atlandi. Os. vil. Where the Army mounted their Horses. I: 65.
Tschirik-atlandi-ostang. Rit. The Canal where the Army mounted their Horses. I: 65 ff.
Tschirimdan-dung. Fo. tr. The Hill of the Tamarisk Towers. I: 26.
Tschi-tsin-chu. Msh. II: 373.
Tschi-tsin-schan. Mt. II: 373 ff.
Tschivilik. Riv. The Mosquito Net I: 419, 425; II: 561, 580.
Tschivilik. Fsh. st. I: 492; II: 596.
Tschivilik. La. II: 299.
Tschivilik. Dist. II: 550.
Tschivilik-kol. La. The Lake of the Mosquito Net. I: 185, 192 ff., 204, 421, 424, 444, 481, 485 ff., 500; II: 305, 333, 345, 347, 518, 548.
Tschoka-tagh. Mt. The Little Isolated Mountain. I: 40 ff., 364; II: 303, 466, 531.

Tschokon-otak. Str. rg. The Drowned Homesteads. I: 212.
Tscholak-dung. Fo. tr. The Hill of the Cripple. I: 61 ff.; II: 554, 556, 580.
Tscholaki-mijani. Trt. II: 218.
Tschol-kol. La. The Desert Lake. I: 40 ff., 325; II: 303, 470, 531.
Tschol-kol. La. II: 164, 165, 206.
Tschol-kuduk. Vil. & st. The Desert Well. II: 62, 67, 66.
Tschol-ottogho. Riv. The Desert Dwelling-Place. I: 430.
Tschol-ottogho-tarim. Old riv. bd. The River of the Desert Dwelling-Place. I: 426, 430.
Tschol-tagh. Mt. ra. The Desert Range. II: 85 ff.
Tschol-tagh. Mt. ra. The Desert Range. II: 78 ff., 84, 98, 100 ff., 117 ff., 173 ff., 222, 367, 454, 461.
Tschol-tau. Mt. ra. The Desert Mountain. II: 78, 387.
Tschol-toghrak. Mt. ra. The Desert Poplar. II: 78.
Tschol-toghrakning-tege. Mt. ch. The Range of the Desert Poplar. II: 77.
Tschong Aghetschadake-kum-tscheke. The Big Sand Promontory of Aghetscha. II: 513.
Tschong-aghis Ca. The Big Mouth. I: 288.
Tschong-aghis. II: 38.
Tschong-ak-kum. Dst. The Great White Sand. II: 537.
Tschong-aral. Fo. tr. The Great Island. I: 75, 96, 113; II: 535.
Tschong-aralning-toghraghi. The Poplars of the Great Island. II: 555.
Tschong-aralning-toghnghi. Fo. tr. The Poplars of the Great Island. I: 113; II: 560.
Tschong-arelisch. Bif. The Great Bifurcation. I: 486.
Tschong-bulak. Sp. The Great Spring. II: 217.
Tschong-hasanak-darja. Riv. I: 108, 110.
Tschong-kemidake-tscheke. The Promontory of the Big Canoe. II: 513.
Tschong-kobruk. Riv. The Big Bridge. I: 118.
Tschong-köl. Fo. tr. with la. The Big Lake. I: 67.
Tschong-kol. La. I: 151, 155.
Tschong-kol. La. I: 382 ff.
Tschong-kol. La. I: 420.
Tschong-kol. I: 433.
Tschong-kol. La. I: 458, 460, 463.
Tschong-kol. La. I: 468 ff.
Tschong-köl. Vil. I: 508.
Tschong-kol. La. II: 10.
Tschong-kol. La. II: 338.
Tschong-kum-kul. La. The Big Sand Lake II: 276.
Tschong-mahalla. Vil. The Great Village. I: 118.
Tschong-ogen Riv. The Big Ogen. I: 110.
Tschong-otak. Sd. The Great Dwelling-Place. I: 123.
Tschong-schakurun. Crt. The Big Cataracts. I: 123.
Tschong-schipang. Old riv. bd. The Great Bank Steppe. I: 385, 386, 391.
Tschong-tarim. Riv. The Great River. I: 101, 104, 205 ff., 408, 425, 426, 433, 445, 493, 501; II: 210, 336, 506 ff., 550, 556.
Tschong-tarimning-koschluschi. Con. The Confluence of the Big River. II: 512.
Tschong-toghrak. Fo. tr. The Big Poplars. I: 65.
Tschong-tottora. Fo. tr. The Great Deserted Region. I: 125.
Tschong-totturu. II: 555.
Tschong-tschapghan-kol. La. The Lake with the Great Canal. II: 510.
Tschong-tschapghan-kolning-aghsi. La. The Mouth of the Great Canal Lake. II: 510.
Tschono-khuduk. Wl. The Wolf Well. II: 287, 291.
Tschorak-kol. La. I: 512.
Tschortschor. Gn. & Sp. The Cataract. II: 18.
Tschu. Riv. II: 444.
Tschubuk. Fo tr. Tamarisk Steppe. or = Tschivuk = New, Young Poplar Shoots. I: 58.
Tschukun Fo. tr. II: 337.
Tschulak-akkan. Mt. & Riv. Where the Armless Man went. II: 370.
Tschulum-attam. La. My Father Tsch. I: 507.
Tschulum Kulluden-ot-katkan. Des. vil. I: 180.
Tschurge. Fo. tr. A region, inundated by an arik (canal). I: 18.
Tsoha. Vil. II: 285.
Tuge-tau. Mt. ch. The Camel Mountain. II: 80 ff., 91.
Tugha-baschi. Fo. tr. & ho. The Camel's Head. I: 103; II: 555, 580.
Tugha-baschi. Fo. tr. II: 10.
Tugha-baschi. Gn & Sp. II: 18.
Tughadake-kol. La. The Camel Lake. I: 160.
Tughadake-kol. La. I: 267.
Tughane-ologhu-jatghan. Str. rg Where the Dead Camel Lies. I: 162.
Tugha-oldi. Str. rg. The Camel Died. I: 213.
Tugha-pangsa The Camels' Grazing-ground. II: 554, 558.
Tugha-pangsa-jokarki-baschi. Fo. tr. The Upper End of the Camels' Grazing-grounds. I: 51; II: 580.
Tughdake-tschapghan. Ca. The Canal of T. II: 152.
Tughu-baschi. La. The Camel's Head. I: 432 ff.
Tuja. Wl. The Camel. II: 176.
Tujang. Fo. tr. I: 103.
Tujdale. Riv. I: 224.
Tukku-su. Riv. I: 7.
Tulum-ischtan. Fo. tr. The Leather Trousers. I: 73.
Tumkara. St I: 67.
Tumschuk. Vil. The Promontory. I: 36, 38, 46, 66 ff.
Tumschuk-tagh. Mt. The Mountain with the Promontory. I: 67.
Tumarluk. Fo. tr. The Iron Place. I: 88.
Tuna-chorak. Rg II: 472.
Tuna-toghdi. Str. rg. Where T Begat a child. I: 212.
Tungani-tuschdi-tscheke Riv. lp The Promontory where the Tungan Encamped. II: 505.
Tungan-tuschken. Str. rg. Where the Tungan Encamped. I: 435.

Tung-chuan. Tn. II: 15, 147 ff., 218.
Tunghan-tuschken. Str. rg. Where the Tungan Encamped. I: 168.
Tung-hoan. Rg. II: 305, 306—300.
Tung-huan. Tn. II: 486.
Tung-lung-tschapghan. Str. rg. The Canal of T. I: 502.
Tung-lung-tschokön. Lp. Where Tung-lung Sank. I: 175.
Tunguslik. Msh. The Region of Boars. II: 86.
Tun-Hung. La. II: 300.
Tunne-kis. Riv. bd. Tunnur = baking-oven; kis = maiden. I: 120, 124.
Tupe-teschdi. Fo. tr. The Hill with the Hole. I: 105; II: 555, 550, 580.
Tuplik-kol. La. The Lakes wrth Lopped Branches and Roots. I: 115.
Tura-ottogho. Pl. The Great Man's House. I: 162.
Tura-salghan-uj. Pl. The House built by the Great Man. I: 162.
Turdu Nias-kemi-tschapghan-toghrak. Ppr. gr. The Poplars where T. N. cut his Canoe. II: 217.
Turduning-soresi. Str. rg. The Hut of Turdu. I: 420.
Turfan. Tn. I: 100, 210, 428, 400, 508 ff.; II: 11, 25, 34 ff., 37, 44, 76, 83, 85, 87 ff., 97, 107, 276, 384, 387, 611 f.
Turfan. Bsn. II: 00, 91.
Turfan-karaul. Fo. tr. The Watch-House of T. II: 11, 34, 36, 38, 41 ff., 52, 326, 583.
Turfan-kobruk. Old Fd. & Br. The Bridge of T. I: 400, 500.
Turfanlik-ottogho. Str. rg. Where the People from Turfan Dwelled. I: 210.
Turkestan., East. I: 5, 11 ff., 20, 64, 60, 73 ff., 82, 94, 101 ff., 247, 291 ff., 317, 333, 346, 350 ff., 364, 373 ff, 380, 383, 387, 404, 484, 488, 409; II: 31, 33, 125, 133, 174, 221, 264, 283 ff., 348 ff., 367 ff., 400, 461 ff., 515 ff., 528, 568, 574, 584, 507 ff., 607 ff., 623.
Turkistan. Prov. II: 200.
Turkomak-kol. La. The Sedge Lake I: 427, 507, 500.
Turkomak-kol. I a. II: 144 ff.
Turkomak-kol. La The Sedge Lake. II: 513.
Turkomaklik-koli. La. The Sedge Lake. II: 152.
Turkomakte-kok-ala. Chl. The River-Branch with Sedge. I: 508.
Turkomakte-kok-alasi. Chl. I: 505, 506; II: 561.
Turkomakte-kok-alasi. Stm. II: 548.
Turkomaktik-kol. La. The Sedge Lake. II: 211.
Turna-toghdi-tscheke. Fo. tr. The Promontory where T. Begat a child. II: 504.
Tus-alghutsch. La. The Lake from which Salt is taken. I: 208; II: 462, 465 ff.
Tus-alghutsch-daschi. Slt. Bd. The Salt Pool from which Salt is taken. I: 420.
Tus-alghutsch-kol. La. The Lake from which Salt is taken. I: 161, 228 ff.
Tuschkun. Str. rg. The Camping Place; litt. Coming down, because here the road from Tscharklik comes down to the Tschertschen-darja. I: 308 —400.
Tusluk-kasch. Fo. tr. The Level Terrace. I: 27.
Tusluk-tagh. Mt. The Salt Mountain. I: 40 ff.; II: 303, 300, 460, 531.
Tus-tau. Mt. Salt Mountain. II: 387.
Tusun-tschapghan. Vil. The Canal of T. I: 510; II: 132, 136, 130 ff., 146, 140, 154 ff., 160 ff., 218, 312, 560.
Tusun-tschapghan-kol. I a. The Lake of the Canal. II: 136
Tuvadake-kol. La. The Hilly Lake. I: 280, 204 ff, 307.
Tuvadaku-kol. La. The Hilly Lake. I: 181.
Tuvekteki-uj. Des. vil. I: 170.

Ubsa-nor. La. II: 381.
Ude. Dist II: 382.
Ugen. Riv. Ugen is said to be synonymous with gun = deep? I: 140.
Ugen-darja. Riv. The Deep River? I: 105, 145 ff, 150 ff., 178, 101, 210, 333, 424, 432; II: 40, 200, 264, 205, 513, 540, 550, 556 ff., 550.
Ugen-darya. Riv. II: 267.
Ugen-tu. Sp II: 77.
Ugusilde. Riv. I: 38.
Uja-kol. La. Nest Lake. I: 237, 208, 307, 420.
Uja-köl-aghesi. Ca. The Mouth of the Nest Lake. I: 237.
Uja-vakkan-dschajir. La. I: 482.
Uj-baschi Busrugvar. Ma. The First House of B. I: 87.
Ujme. Vil. I: 71.
Ujne-aldi-kol. La. The Lake in Front of the House. II: 215.
Ujtun. Vil. The Station. II: 135, 170.
Ujup Baj-ujdake-tscheke. Ho. The Promontory of the House of U. B. II: 513.
Ukarlik-kol. La. The Lake of the Ukar Bird. I: 65 ff.
Ukarlik-kol. La. I: 433.
Ukar-tokkan-kol. La. The Lake where the U. Bird Breeds. I: 115.
Uktasi. La. The Little Lake. I: 180.
Uktudeki-uj. Ho. The House of the Little Lake. I: 180.
Uktu-kol. La. The Little Lake. II: 146.
Uktusu. La. The Little Lake. I: 287, 206.
Ulan-tamanta. Gn. and sp. See Olun-temen-tu. II: 72, 82.
Ulan-tologhai. St. The Red Head. II: 278, 285 ff.
Ullugh-kol. La. The Great Lake. I: 168 ff., 178 ff., 180, 188, 277 ff., 206, 200, 304, 307, 322 ff., 425; II: 335, 344, 466, 505 ff., 510, 514.
Ullugh-kol. Dist. I: 435.
Ullugh-kol. Vil. I: 510.
Ullugh-kolning-aghsi. Mth. The Mouth of the Great Lake. II: 505.
Ullugh-kolning-ak-tarmasi. The White Field of the Great Lake. II: 505.
Ullugh-su. Ml. The Great Water. I: 168.
Ullugh-tschat. Ft. The Great Island. II: 34.
Ullugh-tschol. The Great Desert. II: 504.
Ulterghan. Sp. II: 84.
Ulungur. La. II: 381.

Untschune-uji. Des. vil. The House of the Pearl. I: 512.
Urga. Tn. II: 381.
Urghu-khoitu. La. The Eastern. II: 200, 203, 205, 207.
Urmet-oldi. Fo. tr. Where U. died. I: 118.
Urtang. St. Station. II: 285.
Urtin-nor. La. II: 285.
Urtu-muren. Riv. II: 285.
Uruk-balik. Fo. tr. The Thin Fish. I: 88.
Urulscha-ause. Grg. II: 70.
Urum-basti. Vil. The Suppressed Fighting. I: 7.
Urumtschi. Tn. II: 335.
Urusgha-sal-salghan. Str. rg. The Ferry built for the Russian. I: 430.
Urus-kijik-urdi-bulak. Sp. The Spring where the Russian killed the Antelope. II: 81, 83.
Usagh-kotorma. Dist. The Wide Portage. I: 425.
Uschak-tal. Vil. The Little Willow. II: 38, 86, 93, 97
Uschme-dang. The Inn of Mulberries. II: 37.
Ush Aktal. St. See Uschak-tal. II: 97.
Usmedschan. St. See Utsch-mejdan. II: 85.
Ussupu-jajiri. La. The Little Lake of Ussup. I: 432.
Usulu. Sp. II: 77.
Usum Kullu-daschlik. La. The Salt Pool of U. K. I: 220.
Usun-ada. The Long Island. II: 455.
Usun-agin. Fo. tr. The Long Field. I: 75.
Usun-bulak. The Long Spring. II: 37 ff., 77 ff., 87 ff.
Usun-ilek. The Long River. II: 513.
Usun-jurt. Fo. tr. The Long Village. I: 62; II: 554, 559, 580.
Usun-kara-tschilan. Dist. I: 288; II: 510.
Usun-kol. La. The Long Lake. I: 382 ff.
Usun-kol. La. II: 136, 139, 141, 143, 145, 152.
Usun-kol. La. II: 218.
Usun-schor. Dist. The Long Salt Marsh. I: 300.
Usun-tatir-tscheke. The Promontory of the Long Deserted Region. II: 513.
Usun-tokaj-tscheke. The Promontory of the Long Forest. II: 513
Utschintschi-bajir-kol. La. The Third Depression Lake. II: 505.
Utsch-kol. Ho. and fo. tr. The Three Lakes. I: 126.
Utsch-mejdan. St. The Three Fields. II: 85.
Utsch-toghrak. Fo. tr. The Three Poplars. I: 118.
Utsch-turfan. Tn. II: 353, 566, 601, 605, 611, 614.
Utsch-uj-kol. La. Lake of the Three Houses. I: 116 ff.
Utschuke Serteng-nur. La. II: 285.
Utschu-kol. La. The Lake of the Good Grazing Grounds. II: 160, 184, 250, 280, 330, 363.
Utschu-kul. La. II: 274, 275, 276.
Utu-muren. Riv. II: 278, 285, 370.

Vasch-schahri. Ru. I: 228, 312, 370, 398.

Yao-Tso. La. II: 300 ff.
Yarkand-daria. Riv. The River of the Town on the Terrace. II: 307.
Yarkend. Tn. The Town on the Terrace. II: 300, 612 f.
Yarkent-darya. Riv. II: 272.
Yash-kul. Pl. See Jasch-kol. II: 472.
Yellow River. Riv. II: 380, 382, 384, 441
Yen-Tsö. La. II: 300.
Yurun-kasch. Riv. See Jurun-kasch. II: 272.
Yu-tien. Tn. II: 204.
Yu-ya-tschwan. La. II: 305.
Yuzd. Tn. II: 407.

# INDEX.

Abdal, village, II: 132, 152—153; fluctuations of Tarim at, II: 205; lakes of, II: 152; routes to Astin-tagh, II: 216—218: to Tscharklik, I: 224.
Adoke-kok-alasi, I: 185; dimensions of, I: 186.
Aghis-kol, I: 288, 204, 295.
Agriculture, in E. Turkestan, I: 4, 7, 69—70, 73, 230, 275: II: 597 ff. See also Barley, Maize, Wheat.
Air-currents, Peschel on, II: 398.
Airy, on waves, II: 422.
Ajagh-kol (Kara-koschun), II: 141, 144.
Ajrilghan, I: 19. See Arghan.
Ajsa-tscheke, population of, II: 604.
Ak-bel-kum, Desert of, II: 98, 389—394.
Ak-su, town; altitude of, II: 566: population of, II: 605.
Ak-su-darja, altitude of confluence, II: 570; confluence of with Jarkent-darja, I: 76—82, Pl. 14: II: 516—517, 527, 534: drainage basin of, II: 523: hydrographical relations of, I: 76—81.
Ak-tarma, village, I: 433.
Ala-ajghir, population of, II: 604.
Alak-tschi, II: 372—375.
Ala-kunglek Busrugvar, camp at, I: Pl. 15: eroded bank at, I: 93; ice at, I: 92; masar at, I: 92.
Algæ, I: 264.
Al-katik-tscheke, I: Pl. 25; natives of, I: 131.
Alluvium, in Jarkent-darja, I: 18, 20, 52, 57, 82; in Tarim, I: 88, 89, 90, 104: effects of, I: 154, 187, 196 ff.; at Semilaku-tekgen, I: 221.
Almontschuk-kok-ala, I: 207—208.
Altitudes, method of calculating, II: 585—593; tables of, II: 588—590, 593—596.
Altmisch-bulak, oasis of, II: 74—76, 120—121, 222—223.
Aminoff, G., on sand specimens, II: 462, 467—470 and II: 455.
Anambaruin-gol, II: 472.
Andere, altitude of, II: 570.
Andere-terem, I: 375.
Andersson, Dr. J. Gunnar, on Ostracods in sand, II: 456.
Andischan merchants, I: 94.
Antelopes, I: 26, 71, 289, 348, 495; II: 19, 75, 119, 180.
Anville, d', map of, II: 373—375.
Ara-kum, irrigation of, I: 176.
Araltschi, I: 396.
Ara-tarim. Se Kuntschekisch-tarim.
Arghan, or Ajrilghan, I: 191: depth at, II: 580: isobathic map at, I: Pl. 35: position of, II: 271—273: volume of Tarim at, I: 260. See also Confluence.
Arka-darja. See Lajlik-darja.
Arka-kol, I: 472—474, 479—481, 483: II: 304—305, 331—335, 341—346: altitude of, II: 581: depth of, II: 580: view of, II: 343.
Arkharis, wild sheep, II: 19.
Armand David, II: 380.
Arocha, d', II: 273.
Arrhenius, on dunes, II: 397, 413.
Arschin, or Artscha, juniper, II: 17.
Aschâk-kamutsch (plant), I: 334.
Astin-jol, road, I: 370—376: II: 493: view of, I: 373.
Astin-tagh, routes from Abdal, II: 216—218; steppe N. of, II: 473.
Atschik-darja, south of Tarim. See Lajlik-darja.
Atschik-kuduk, altitude of, II: 579.
Atschik-tarim, I: 398.
Author, investigation of Jarkent-darja, I: 10—82: criticises Kosloff, II: 91, 173—174: on derivation of drift-sand, II: 444—451: on dune-formation, II: 414, 436 n.: his journey across the Kuruk-tagh, II: 104—121: on Lop-nor controversy, II: 262—376; on wave-movement, II: 416—439.
Avat, population, I: 80.
Avenues, of trees, I: 4, 7, 9.
Avullu-kol, I: 486, 493—494: II: 304—305, 331—335, 341—346: depth of, II: 580.

Baba-tarim. See Tschong-tarim.
Baer, v., II. 13.
Baga-ghaschon, II: 290—297.
Baghrasch-kol, II: 389—394: altitude of, II: 567: drainage-area of, II: 523.
Bajir-kol, I: 279, 287, 299, Pl. 43.
Bajirs, I: 248—251, 311—369: arguments from presence of, II: 347—348: compass-bearings of, I: 349—350, 355: distribution of, I: 328, 363.

Pl. 52: general laws of, I: 362—363: sanded up, I. 339—340: salt water in, I: 265: wind effects upon, I: 248—250, 332: of Jangi-kol, I: 235, 236: in Desert of Lop, II: 229—231: in Takla-makan, I: 364: of Toghraklik-kol, I: 265—267: sketches of, I: 316, 340, 357, 365—367, Pl. 47, 48, 49: views of, I: 315: II: 347.

Barat Kulning-kol, channel to, I: 475.

Barkhans. See Dunes.

Barley, I: 71.

Barrett, expedition of, II: 574.

Baschin, on sand-waves and water-waves, II: 413—414 n., 417—418 n., 422 n.: on dune movements, II: 406 n., 411 f., 436.

Basch-kol, I: 233—234, 237, 253, 298, 304, Pl. 43: dimensions of, I: 290.

Baschtage-kol, I: 289, 299, 306.

Basch-toghrak, II: 13—15.

Bathymetrical data. See Soundings and Isobathic maps.

Beetles, II: 75.

Begelik-kol, I: 287, 290, 294—297, 298, 304, 306: II: 344, 510—511: dimensions of, I: 299: isobathic map of, I: Pl. 46.

Bei-schan, mountains, II: 98, 99, 100, 105.

Bej-san. See Bei-schan.

Beks, of Turfan, I: 409.

Bellew, on sand encroachments, II: 407 n.

Bird-trap, I: 50.

Blanford, II: 368.

Bogdanovitsch, on Central Asia sand, II: 387—389, 441: on E. Turkestan hydrography, I: 78, and II: 146, 212, 264, 269, 301, 407, 443, 446, 448, f.

Boldschemals, formation of, I: 195—207, 209, Pl. 36, 37: of Jatim-tarim, I: 423—424.

Bolscheff, II: 285.

Bonvalot, II: 264, 271.

Bos-ilek (river), I: 425, 486—487, 495: II: 10, 548: dimensions of, I: 496.

Bos-kol, I: 186—187.

Bostan-toghrak, I: 373, 375, 378, 379: fall of, II: 570: ice on, I: 378—379; vertical sections, I: 378, 381.

Brick-kilns, I: 503.

Bridges, I: 4, 5, 6, 66, 159, 428, 432, 453, 465, 467: II: 5, 518.

Buddha, images of, at Lôu-lan, II: 634, 643.

Burial-place. See Ghuristan and Gumbes.

Busrugvar, altitude of, II: 570.

Buzzard (Buteo), II. 4.

Bystrom, H., Major, II: 574—575.

**C**amel, wild, I: 144, 227, 289, 466—467: II: 52, 53, 75—77, 112, 113, 119, 185, 474, 497.

Canoes, native, I: Pl. 53, 54: on Begelik-kol, I: 290: on Tarim, I: 99, 102.

Carey, on Tarim, I: 100: and Kitschik-ogen, I: 110: II: 98, 264, 270, 567.

Cataracts, in Ilek, I: 486: of Jemischek-kok-ala, I: 429: in Kontsche-darja, I: 503; in Kotaklik-darja, I: 23: in Schor-kol canals, I: 35, 36.

Cattle, I: 219.

Caves, earth, I: 84.

Cementation, by sediment, in desert lakes, I: 262—267.

Chaidu-gol, II: 516, 518; drainage-area of, II: 523.

Chaneka, oratory, I: 59—60

Chara-narin-ula, depression of, II: 384.

Chara-teken-ula, II: 26, 79, 94, 95—98.

Chinese, and irrigation in E. Turkestan, I: 69, 73: maps, II: 277—297; navigate Tarim, I: 139—140; taxes, I: 370: tribute to, I: 499.

Chirki-darja, a name for the Tarim, I: 126.

Chladni, II: 414.

Cholnoky, on dune coalescence, II: 408; on ripple-marks, II: 409 f., 418.

Chotan, town, altitude of, II: 567 n.: kingdom of, II: 367; population of, II: 605.

Chotan-darja, I: 411; II: 517: altitude at confluence, II: 569: confluence with Tarim, I: 84—86: drainagebasin of, II: 523: fall of, II: 570; hydrographical relations of, I: 77, 79, 82: Grenard on, II: 309

Chordschas, settlers, I: 508: II: 37.

Chua-chai-tsi, lake, II: 372—375.

Churtuk-tau, II: 96.

Clavijo, II: 405.

Clay, foundation of deserts, I: 245: terraces, beside Astin-jol, I: 370: of Kuruk-tagh, II: 104: wind-sculptured, in bajirs, I: 317, 322, 323. See also Jardangs.

Climate, about confluence of Chotan-darja, I: 86—87.

Compass-bearings, of bajirs, I: 349—350, 355: in Desert of Tschertschen, I: 313.

Confluence, Turkish words for, I: 137 n. 101.

Conrady, A., II: 264, 610.

Contours, of Tarim basin, II: 565 ff.

Cooking-pot, iron, found in Kuruk-tagh, II: 106—107, 109.

Cordier, H., resumé of Lop-nor problem, II: 313.

Cornish, on heights of dunes, II: 400: on origin of barkhans, II: 437: on ripple-marks, II: 410—411, 412, 427, 430, 433—434, 436.

Cotton, cultivation of, I: 9.

Crows, I: 26, 440.

Currents, of air, II: 398: of sand, II: 426—427.

**D**algleish, II: 264, 271, 567: on Tarim, I: 100: and Kitschik-ogen, I: 110.

Dams, I: 504, 510, 511: across Jarkent-darja, I: 22: at Jusup Bekning-toghi, I: 65; in Kara-koschun, II: 137: across a Kona-darja of Jarkent-darja, I: 38—39: beside Tschertschen-darja, I: 386.

Dancers, native, I: Pl. 5.

D'Anville, map of, II: 373—375.

Daschi-kol, I: 230—231, 298, Pl. 43: and Tarim, I: 308.

Davan, meaning of, II. 281.

Day-fly, in desert, I: 324.

Deer (roe-deer, red-deer), I: 71, 280, 289, 348, 389: II. 128.

De Geer, on sand specimens, II. 455, 462—470: on secular elevation of Scandinavia, I: 302.

Desert, sandy, compared to sea, II: 436. See Lop, Takla-makan, Tschertschen, etc.

Desiccation rings, in bajirs, I: 325—327.
D'Espinha, II: 271, 273, 275, 277.
Dilpar, routes from, to Jing-pen, II: 11.
Distance, measurement of, I: 8.
Dragon Town, of Lop-nor, II: 301.
Drainage-basin, of Ak-su-darja, I: 78; of Baghrasch-kol, II: 523; of Chaidu-gol, II: 523; of Chotan-darja, II: 523; of Jarkent-darja, I: 78; of Kara-muran, II: 523; of Kaschgar-darja, II: 523; of Kerija-darja, II: 523; of Tarim, I: 291—293, 302—303; II: 369—370, 441—461, 524, 565—584.
Drift-dust. See Dust and Haze.
Drift-sand, and wind, I: 254; Central Asian, II: 387—389; in Chara-narin-ula depression, II: 384; in Desert of Ordos, II: 380—383; and Kara-koschun, II: 132—134; Loczy on, II: 407 n., 443—444. See further Dunes.
Driftwood, in Jarkent-darja, I: 10; on Tarim, I: 90, 118, 123, 126, 177.
Dunes, altitude of, I: 253, 275; II: 396—397, 400; on bajir thresholds, I: 315; coalescence of, II: 408; festoon arrangement, I: 320; formation, theories of, I: 335—336; II: 410—439; relation to desert lakes, I: 239—244; movements of, I: 355—360; II: 402—407, 415—439; and rivers, I: 160—161, 167, 411; shapes of, I: 331—332, 351, 363; two systems of in Desert of Tschertschen, I: 360; and tamarisks, I: 387—388, 401; types of, I: 323; and vegetation, II: 351; and wind, I: 170—174; Fritsch on origin of, II: 398—399; Konschin on, II: 403; Penck on origin of, II: 398, 400; Sokolow on, II: 392, 400, 403; in Chara-narin-ula depression, II: 384; near Chotan-darja, II: 568; in desert of Gobi, II: 479—480, 484—485, 493, Pl. 45, Pl. 40; beside Jarkent-darja, I: 62; to N. of Kara-koschun, II: 126, 165, 187; between Kaschgar and Lajlik, I: 7, 10; beside Kotaklik-darja, I: 24—25; Desert of Kum-tagh, II: 385—387; in Desert of Lop, II: 66—67, 243—244; Mongolian, II: 380; in Desert of Ordos, II: 380—383; beside Tajek-köl, II: 581; in Takla-makan, I: 364; beside Tarim, I: 98, 106, 120—122, 145, 166—180, Pl. 23, 32, 33, 34; at Tokus-kum, I: 130, Pl. 24, 32, 33; Trans-Caspian, II: 404—405 n.; beside Tschertschen-darja, I: 394.
Dune-accumulations, I: 269—276, 331, Pl. 44; extent of, I: 253; formation of, I: 352—354; movements of, I: 271—275, 320; pressure of, I: 245—246; and Tarim, I: Pl. 48, 50; in Desert of Tschertschen, I: 355—360, 362, Pl. 51, 52.
Dung-agil, altitude of, II: 571.
Dungans. See Tungans.
Dung-kotan, double loop at, I: 98.
Dunglik, II: 218.
Dural, I: 428, 505.
Dust, in a dust-storm, I: 290—291; circulation of, in Tarim basin, I: 291—293.
Dust-haze. See Haze.
Duveyrier, II: 398.

Eagles, I: 26, 174, 280.
Earthenware vessels, at Lôu-lan, II: 618, 625, 627, 632.
East Turkestan. See Turkestan, East.
Ekholm, Dr. Nils, methods of determining hydrometric data, I: 28—33; and heights above sea level, II: 340, 565 f., 569, 576, 579, 583 f., 585—593.
Eleagnus, bushes, I: 157, 158, 165, 175.
Emin Achune-uktusu, I: 244—245, 251.
Empen. See Jing-pen.
Erosive action, of Jarkent-darja, I: 56; of Tarim, I: 88—90, 93, 98, 138—139, 195—205.
Espinha, II: 271, 273, 275, 277.
Ettek-sala, I: 488, 490.
Ettek-tarim, I: 191, 207, 300, 402—416; II: 547; compared with Tarim, II: 337—340; relations to Tarim, I: 405—406, 408; views of, I: 403, 411—413.

Fajs-abad, population of, II: 604.
Fajs-abad-darjasi. See Kona-jaman-jar.
Falcons, hunting, I: 134
Ferry, at Turfan-karaul, II: 519.
Ferry-boat, I: 10, 13, 17, 20, 87, 88; I: Pl. 4, 27.
Fish, bones of at Lôu-lan, II: 631, 642; in Jarkent-darja, I: 228—229; in Kara-koschun, II: 131—138, 142—143, 148, 149; mortality amongst, II: 131—138.
Fishing, industry, I: 115, 126, 134—135, 137, 140, 477, 479; II: 642; in Schor-kol canal, I: 35, 36; in Ullugh-kol, I: 280.
Fish-nets, I: 477.
Fish-skins, as signposts, I: 126.
Fish-trap, I: 83, 92, 93, Pl. 16.
Fleas, II: 75.
Floating islands, I: 489.
Fords, in Tarim, I: 116.
Forel, on water-waves, II: 419.
Forests, beside Jarkent-darja, I: 13, 17, 18, 19, 26, 27, 47, 52, 53, 60, 87, 88, Pl. 13; beside Kerija-darja, II: 350; beside Kuntschekisch-tarim, I: 499; in Desert of Lop, II: 257—258, 302—303; beside Tarim, I: 98, 103, 114, 123, 136, 141, 151, 177; beside Old Tarim, I: 190, 191; beside Tschong-tarim, I: 210, 213. Se also Toghrak.
Forsyth, on the Kuruk-tagh, II: 97, 220, 295, 611 ff.
Foxes, I: 26, 233, 332, 348, 440, 495; II: 58, 75, 128, 180, 252.
Friedrichsen, II: 97, 516.
Fritsch, on origin of dunes, II: 398—399.
*From Kulja*, by Pschevalskij, quoted, II: 97, 109.
Futterer, on Kuruk-tagh, II: 98, 102—103, 111.

Gad-flies, I: 192, 208, 220, 375.
Garnak, Mr., II: 380.
Gas-nor, II: 278—279.
Geikie, James, II: 368.
Ges-darja, I: 6—8; II: 533.
Ghas, Lake. See Gas-nor.

Ghaschun-gobi, II: 117—118. 118—121.

Ghol-kol, I: 288. 294. 295: II: 510.

Ghuma. population of. II: 605.

Ghuristan. burial-place. I: 34: II: 31—32. 33: at Markat. I: 127: of Saj-tagh, I Pl. 11. 46.

Glacier, movements of. II: 418.

Gnats. I: 375. 484.

Gobi. Desert of. II: 470 500: desert range in. II: 473. 475. 476 479; dunes in. II: 484 485. 493; jardangs in. II: 489; kamisch in. II: 490—492: poplars in. II: 400; old road in. II: 475—476: tamarisks in. II: 400 492; views of. II: Pl. 45. Pl 46. 47. 40. 50 and 54: old watercourse in. II: 480 483.

Gold mines. at Altin-tagh. II: 03: of Altun-keni. II: 17.

Golme-katgen-kol. II. 148. 149.

Golme-kati-kol. I: 239. 244—245. 250—251. 206. 208. 304. 306. Pl. 43: dimensions of, I: 209: isobathic map of, I: Pl. 41. 46 *a*.

Grenard. F., on altitude of Chotan. II: 567 n.: on East Turkestan. II: 308—300: on Lop-nor. II 310—313. and 567. 568. 613. 614.

Grigorieff, cited. II: 263—264. 270. 610.

Grimm. 373. 375.

Grum-Grschimajlo. G. J., on Desert of Kum-tagh. II: 386—387: on the Kuruk-tagh. II. 25—26, 70—84. and II: 72. 78. 82 f. 01 f., 08, 104. 374 f., 300.

—, M. J., controversy with Obrutscheff. II: 371—375.

Gulls. II: 127. 128.

Gumbes. tomb. at Saj-tagh. I: Pl. 11. 46: at Kara-saj. I: 52.

Gunther. on dune-formation, II: 413.

Hajdar. II: 70.

Hallerstein, II: 271. 273. 275. 277.

Hami, Desert of, II: 98—99.

Han-hai, von Richthofen on, II: 307.

Hann. on ocean-currents. II: 425.

*Han-schu*, referred to, II: 287—289.

Hares. I: 26. 71. 233. 256, 280. 328. 332. 348. 380. 440. 495; II: 19. 58. 110. 128. 131. 180. 252.

Hasret-i-achtam Resi Allahu Anhu, shrine of, I: 59—60.

Hassenstein. Dr. B., I: 312: II: 27. 41. 566, 567. 583.

Hawks. I: 146.

Haze, as meteorological factor, I: 247, 293.

Hedgehog. II: 131.

Heim. II: 418.

Helmholtz. II: 411, 413.

Himly. on names of Lop-nor, II: 300—301: his Report. II: 276 277: translation of *Si-yu-schuei-tao-ki*, II: 277—278. 287: comments on. II: 260, 264, 280 f., 285. 288. 290. 291. 312.

Hirth. II: 288.

Holderer. II: 08. 102

Homologies. geographical. I: 255. 282.

Hunting. in East Turkestan. I: 134; II: 608.

Huntington. expedition of, II: 574.

Huts. square (*gerem*). I: 386: old. beside Kara-koschun. II: 178—179. 181: at Sejt-kol. I: Pl. 30: of shepherds. I: 37. Pl. 12. See also Satmas.

Hydrography. of Ak-su-darja. I: 76—81; of Chotan-darja. I: 77. 79, 82: of Ilek-system. I: 402: N. of Kara-koschun. II: 191—202: of Kodaj-darja. I: 64—68: of Kuruk-darja. II: 3. See also Jarkent-darja and Tarim.

Hydrometrical data. methods of determining. I: 28—33. 27. See also Jarkent-darja and Tarim. dimensions.

Hypsometrical relations of Tarim basin, II. 563 f.

Ice. at Ala-kunglek Busrugvar. I: 02: on Bostan-toghrak, I: 378—379: on Jangi-kol. I: 236—237: on Jarkent-darja. I 17: on Tarim. I: 92. 94—95. 96. 142—144, 147—148. 163—164, 456: on Tschertschen-darja. I: 348. 382—387. 396.

Igertschi-tagh. II: 86. 95.

Ighis-dung. I: 169—170.

Ike-gaschon. II: 290—297.

Ilek. river. I: 425. 427. 463. 465. 468. 470—476. 484—486. 489: cataracts in. I: 486: depth of. II: 580: as barrier against sand. II: 339—340: dimensions of. at Kum-tscheke. I: 472—473: at Islamning-uj. I: 474—475: at Camp XXXV. I. 476: at Kotoroma. I. 482; at Kum-tscheke. II: 330: at Ordek-jaghutsch. II: 332. 337. 338: forest beside. I: 406: II: 342: hydrography of. I: 402: views of. I: 469—473.

Iltirghan. oasis of. II: 80.

Intschka-darja, or Tscha-jan. I: 102. 104. 109: II: 10. 539: at Tschong-tokaj. II. 439.

Irrigation. law of (novot). I: 68—69: Chinese and, II: 69. 73: effects of upon Tarim. II: 353 354: in E. Turkestan. I: 73: at Ara-kum. I. 176: at Dural. I: 505; at Jangi-arik. I: 7: at Jangi-schahr. I: 5: at Kakde. I: 115: from Kodaj-darja. I: 64—68: to Maral-baschi. I: 21—36.

Islamabad. population of. II: 604.

Islands, floating. I: 489.

Isobathic maps. of Begelik-kol. I: 204—207. Pl. 46. 46*a*: of Golme-kati. I: Pl. 41. 46*a*: of Karaunclik-kol. I: Pl. 41. 46 *a*; of Tarim. at Arghan. I: Pl. 35: of Toghraklik-kol. I: Pl. 41: of Ullugh-kol. I. 282. Pl. 45. 46 *a*.

Jakan. bush. II: 147. 149. See also Sedge.

Jakänlik-kol. II: 143.

Jakän-oj. I: 449.

Jakinf. maps of. II: 373—375.

Jaman-ilek. I: 436.

Jangi-darja. or New Tarim. I: 90—94.

Jangi-hissar. population of. II: 605.

Jangi-jer. lake. I: 440.

Jangi-kol. I: 234—238. 253. 298. 304, 307. Pl. 43: altitude of. II: 586; dimensions of. I: 299: head-quarters at. I: 161—162; position of. II: 586: views of. I: Pl. 31; volume of Tarim at. I: 260.

Jangi-su. district. I: 493.

Jangi-tarim. See Ilek.

Jangi-uj, depth of Tarim at, II: 580.
Jantak, scrub, I: 370, 371, 392; II: 11: 71, 477.
Jardang-bulak, springs of, II: 54—55.
Jardangs and gullies, II: 115—116; N. of Kara-koschun, II: 165, 168 186—187; beside Kuruk-darja, II: 53, 56, 59, 65 f.: in Desert of Gobi, II: 489, 493; in Desert of Lop, II: 224—231, 236—242, 314: beside old bed of Tarim, I: 439.
Jarkent, town, altitude of, II: 570; population of, II: 605.
Jarkent-darja, II: 527, 534, 542; alluvium in, I: 18, 20, 52, 57: author's investigation of, I: 10—82: author's plan of work, I: 11; banks of, I: 48, 50, 75, 84: II: 530—531: confluence with Ak-su-darja, I: 76—84, Pl. 14: dimensions, table of, II: 588, 599: at Lajlik, I: 12—13: at Bisch-kol, I: 16; at Schäschkak, I: 17; at At-pangsa, I: 18; at Sekakkal-otak, I: 19; at Läschlik, I: 26; at Jalghus-jidge, I: 26: at Kijik-tele-tschol, I: 27; at Haradighan-kotak, I: 28; at Kuruk-asti, I: 37; at Sorun, I: 41; at More, I: 47; at Milka, I: 48; at Ak-satma, I: 49: at Duga-dschaji, I: 48, 50; at Tugha-pangsa-jokarki-baschi, I: 51; at Toghri-kum, I: 51; at Islik, I: 53: at Kujluschning-baschi, I: 53: at Jar-kotan, I: 56; at Atschi-dung, I: 58; at Kalmak-kum, I: 61; at Usun-jurt, I: 63; at Matan, I: 64: at Hangetlik, I: 72; at Jesi-kol, I: 74 (Continued under Tarim); drainage-basin of, II: 523; driftwood in, I: 19; fall of, II: 570; in flood, I: 54 n.: highwater marks of, I: 48; hydrographical relations with Ak-su-darja, I: 76, 81; lagoons beside, I: 72; loops of, I: 14, 20, 54, 55, 71; scenery beside lower, I: 68, 70: tendency to shift bed, I: 18—19; turbidity of, I: 57, 73 (see Transparency): velocity of, I: 15; view of from Kuruk-asti, I: Pl. 6; volume, causes affecting, I: 11; at Lajlik, I: 12, Pl. 3, Pl. 4: below Lajlik, I: Pl. 5: water-supply to, I: 54, 74.
Jar, erosion terraces, II: 17.
Jarsuk, or jarsik, I: 190, 213, 214.
Jas-julghun, population of, II: 604.
Jatim-tarim, I: 192, 193, 203, 204, 419, 420—423, 424, 487—488, 490—491, 497; dimensions, at Tagirman, I: 486: above Tschivilik-kol, I: 491; below Kuntschekisch-tarim, I: 500, 501; at Schejtlar, I: 501: at Sakitma, I: 501.
Jemischek-kok-ala, I: 192, 193, 204, 419, 424, 497: cataract in, I: 420.
Jemischek-kok-alasi, I: 192, 193, 204.
Jempen. See Jing-pen.
Jigde, plant, I: 403: II: 48, 59.
Jilgha, at Gadschir, I: 99—100.
Jing-pen, I: 427; altitude of, II: 571; described by Kosloff, II: 30: identical with Ju-jing-pen, II: 583; routes to, II: 11, 38, 41: ruins at, II: 30—35; toras of, II: 31, 33: wall at, II. 39—42.
Jordan, II: 400.
Ju-jing-pen, fort at, II: 39—42: identical with Jing-pen, II: 583.
Jul-annam, mountain, I: 40: panoramic view of, I: Pl. 10 *a*.
Julghun-kol-kuduk, well, I: 404.
Jumalak-darja, I: 113—120. See Tarim.
Jurt-tschapghan arm, II: 153—158, 161—164: Chinese fort, II: 162: dimensions of Tarim at, II: 204—205: natives of, I: 224.
Jurun-kasch, II: 523, 526.

Kade-dung, altitude of, II: 570.
Kadike, village, I: 403—494: population of, I. 604.
Kak, silt expanses, II: 63.
Kakde, on Tarim, I: 115.
Kalka, view of glen of, II: 393.
Kalmak-ottogho, I: 506—507, 510, 511.
Kalmucks, II: 93, 94.
Kalta, altitude of, II: 571.
Kalta-natschuk, population of, II: 604
Kamisch. See Reeds.
Kan-arik, population of, II: 604.
Kan-arik, canal, I: 6, 9.
Kanat-baghlagan-kol, I: 125—128, 144.
Kan-joli, King's Road, I: 431.
Kan-su, deserts of, Loczy on, II: 395.
Kara-akin, branch of Tarim, I: 113, 114, 115, 116, 119, 123.
Kara-buran, I: 223, 289—293, 399: in 1896, II: 198—200; shrinkage of, II: 350.
Kara-jaghatsch, bush, II: 17, 23.
Kara-kasch, II: 523, 526.
Kara-kisil, range, II: 86.
Kara-kol, I: 486, 488—489, 494, Pl 55: II: 304—305, 331—335, 341—346; depth of, II: 580.
Kara-koschun, lake, II: 125—218, 294: altitude of, II: 584; depth of, II: 293, 580; dimensions of, II: 203—208; and driftsand, II: 132—134; fish in, II: 131—138, 142—143, 148, 149; hydrographical relations N. of, II: 191—202; nomenclature of, II: 140—141, 211; relations to desert lakes, I: 261—262, 300; shores of, II: 165—202: shrinkage of, II: 353—354, 359—365; views of, II: Pl. 14, 17.
Kara-kum (Caspian), Walther on, II: 415, 444—445.
Kara-kum, colony, I: 427; population of, II: 604.
Kara-muran, river, I: 329, 373, 374, 375: drainage-basin of, II: 523.
Karaul, distance from Lajlik, II: 575.
Karaune, water-fowl, I: 288, 483.
Karaunelik-kol, compared with bajirs, I: 319: compared with Ullugh-kol, I: 284—285; dimensions of, I: 299; isobathic map of, I: Pl. 41; relations to Tarim, I: 258—262: in Schirge-tschapghan district, I: 252—262, 298, 304, 451, 457, 458, Pl. 43; II: 344.
Karghalik, population of, II: 605.
Kaschgar, altitude of, II: 569: town, population of, II: 605.
Kaschgar-darja, II: 517, 522, 533, 534: altitude of, II: 569: confluence of with Jarkent-darja, I: 63, 73; drainage-basin of, II: 523.
Katik-arik, I: 288, 296.
Katschung, population of, II: 604.
Keidel, H., Dr., II: 566.
Keng-lajka, I: 348.
Kerija, Desert of, II: 221.
Kerija, town, population of, II: 605.

Kerija-darja, I: 79, 79 n., 411: drainage-basin of, II: 523: fall of, II· 571: forest beside, II: 350: Grenard on, II: 309: Stein on, II: 309, 349—350.
Khas-nur, II: 278—279, 281, 295—296.
Khas-omo, II: 278—279, 295.
King's Road, I: 431.
Kirghuj Pavan, I: 207.
Kirk-saj, I: 373.
Kirtschin, branch of Tarim, I: 176.
—, volume of Tarim at, I: 260, 286.
Kisil-boje-darja, river, I: 5—6, Pl. 1.
Kisil-kum (Caspian), sand of, II: 444.
Kisil-sangir-tagh, II: 93—95.
Kisil-su, river, I: 3—6: II: 533.
Kisil-sinir, village, II· 87, 92—93.
Kitschik-ogen, I: 119.
Kjellstrom, Lieut., II: 575.
Klaproth, II: 373.
Kodaj-darja, hydrographical relations of, I: 64—68: as irrigation channel, I 36.
Koeppen, II: 367.
Kol, in Chotan-darja, II: 566; in Kara-koschun, II: 137.
Kok-ala. See Jatim-tarim; also Kuntschekisch-tarim.
Kona-Abdal, land and water at, II: 212.
Kona-jaman-jar, river-bed, I: 4.
Kona-schahr, near Andere, I: 376.
Kona-tägirman, old river-bed, II: 5—6.
Konschin, on dune movements, II: 388, 403 407.
Kontsche-darja, I: 487, 497, 499—508; II: 516—521, 548; as barrier against sand, II: 335—336; bridge over at Korla, II: 518; connections of, I: 302, 427—428: II: 3; at Dilpar, II: 8—9; fall of, II: 571: Kosloff's views on, II: 299—300; measuring it through ice, II: 9: migrations of, II: 11—12; terminal stream of, II: 130: near Tikenlik, II: 519; vertical section of, II: 7; volume of, I: 457.
Koral-dung, native maps of country round, I: 109, 110; view of Tarim at, I: Pl. 18.
Koral-dunghing-kol, I: 111: view of, I: Pl. 17.
Korat-bulak, altitude of, II: 570.
Korla, altitude of, II: 567; bridge at, II: 518; population, II: 605.
Koschalantsa, altitude of, II: 570.
Koschmet-kol, lake, I: 400, 401.
Kosloff, author criticises, II: 91, 172—174; on Jing-pen, II: 30, 583: on country from Jing-pen to Turfan-karaul, II: 38; on old river south of Jing-pen, II: 36, 43; on Kara-koschun, II: 173—175; on Kuruk-darja, II: 3—4, 43; journey of, in Kuruk-tagh, II: 85—91; on Kuruk-tagh, II: 26, 38, 111: on Lop-nor problem, II: 269—306; his lake Soghot, I: 477; and II: 10, 24, 34 f., 40 f., 52, 63, 72, 74, 79, 81, 93, 95, 98, 121, 140, 176 f., 201, 207, 235, 259, 263, 265 f., 311, 375, 421, 579, 582, 583.
Kotak, dead poplars, I: 414; heaviness of II: 125—126: beside Ettek-tarim, I: 403: beside the Jarkent-darja, I: 40; beside Kuruk-darja, II: 4, 45, 48, 49—51, 57, 59, 61, 64, 70: beside Tschertschen-darja, I: 305.
Kotaklik-darja, I: 21, 22; dimensions of, I· 22—23, 24, 25.
Kotaklik-kol, lake, I: 459: mud-banks in, I: 460—461.
Kouruk (tamarisk), I: 346, 392, 400; II: 14, 73, 170, 183, 253, 473.
Krapotkin, Prince, II: 310; his criticism of Author, II: 306—308; on the desiccation of Central Asia, II: 366—368.
Kreitner, II: 373, 380.
Krummel, on wave-movement, II: 419, 423—424, 427—428.
Kuduk, altitude of, II: 570.
Kujusch, I: 210.
Kulatscha, village, I 464, 465.
Kum-darja. See Kurak-darja.
Kum-kol (Kara-koschun), II: 137; Tschernoff's sketch of, II: 507.
Kum-tagh, Desert of, II: 384—387; compared with Desert of Tschertschen, II: 309.
Kum-tagh, in Desert of Gobi, II: 485—488.
Kum-tschapghan, II: 131—132: altitude of, II: 571.
—, arm, II; 153—156, 159—160, 162—164.
Kum-tscheke, village, I: 466.
Kuntschekan Bek, II: 152.
Kuntschekisch-tarim, I: 424—425, 429—431, 498, 499, 508: II: 548: compared with Tarim, I: 431—432; dimensions at Camp XLII, I: p. 504: near Kalmak-ottogho confluence, I: 506; at Kirtschin-kotan, II: 547.
Kuropatkin, II: 96; and altitude of Ak-su, II: 566: on altitude of Korla, II· 567, 598, 610.
Kurugen-ogen, river, I: 141—142.
Kurtsch-aghil, 379—380.
Kuruk-darja, described, II: 44—63; altitudes of, II: 571, 583, 584: author's trip to, II· 29—73: bed of, II: 60—61, 69: drainage-basin of, II: 523: fall of, II: 571; Kosloff on, II: 3—4, 43; poplars beside, I: 430: relations to Kontsche-darja, II: 3: sketch of, II: 36.
Kuruk-tagh, altitude of, II: 583; Author's journey in, I: 104—121: Author's view of, II: 98; clay terrace of, II: 104: country south of, II: 44—73, 76, 471 ff., 584; Forsyth on, II: 97; Futterer on, II: 102—103; Grum-Grschimajlo's journey in, II: 79—84: iron cooking pot found in, II: 106—107, 109: Kosloff on, II: 111; Kosloff's journey in, II: 85—91: old road discovered in, II: 107, 118; orography of, II: 78—121; Prschevalskij on, II: 97—100: relations to Kurak-darja, II· 28—30: Roborovskij's journeys in, II: 93—96, 100—102: scenery in, II: 19—28: snow in, II: 108: southern slopes of, II: 61, 73, 76: springs in, II: 110—121: system of, II: 24—28: views of, II: 121, 303, Pl. 7, 9, 11 and 53.
Kutschar, altitude of, II: 567: population of, II: 605.

Lagoons, beside Jarkent-darja, I: 72: beside Tarim, 109—112, 114, 122, 144—145.
Lajlik, altitude of, II: 570; distance from Karaul, II: 575.
Lajlik, Tarim at, II: 542—545.

Lajlik-darja, also Atschik-darja, Arka-darja, and Opghan-darja. I: 88, 92, 94, 95, 107, 113, 127—128, 137—138, 459—461.

Lakes, desert, general conclusions, I: 298—308: origin of their canals, I: 229, 233: relations to dunes, I: 239—244; sediment and bottom of, I: 262—267; beside lower Tarim, I: 228—308; relations to Kara-koschun, I: 300; relations to Tarim, I: 178—179, 258—262, 300; relief of region, I: Pl. 49; topography of, I: Pl. 47; water in, I: 267—269.

Lakes, marginal, I: 144—145: relation to Kara-koschun, II: 207—208; effect of upon Tarim, II: 356—357.

Lake, New, N. of Kara-koschun, II: 167—170.

Lalmoj, marsh, I: 38 n., 49, 66 n., 67, 19 n.

Lapparent, de, on wind-power in deserts, II: 459—460.

Largeau, M., II: 397.

Laschin-darja, I: 183—184, 486—487, 500, 501; II: 546, 548; connections of, I: 425, 428.

Lava, movements of, II: 418—421.

Lead, mines, II: 74—75; in Kuruk-tagh, II: 86, 87, 93; smelting of, II: 74.

Level, oscillations of in river, how determined, I: 27; of country of lower Jarkent-darja, I: 70: changes of, in Tarim, I: 351: at Jangi-kol, I: 162—165: at Kirtschin, I: 177—178: at mouth of Ugen-darja, I: 150—157; of Tschertschen-darja, I: 351, 384.

Levelling, of Desert of Lop, II: 234—253, 314—329.

*Limnæa.* See Mollusc shells.

Limnology. See Lakes.

Littledale, on Kara-koschun, II: 176—175, 218, 264, 271, 287, 471 f., 478, 486, 493, 566.

Lizards, I: 440.

Loczy, on sand-buried cities near An-si-fan, II: 407 n.; on drift-sand near Lake Po-yang, II: 394 f., 443—444, 447, 486, 488: on Kan-su deserts, II: 395; on agency of wind, II: 488—489.

Loops of Jarkent-darja, I: 14, 20, 54, 55, 71; double, I. 98, 205—207, 209: of Tarim I: 89: at Dung-kotan, I: 98: at Tokum, I: 210: at Tschong-otak, I: Pl. 19: at Tung-lung-tschokon, I: 175; opposite the Ullugh-kol, I: 169.

Lop, country, I: 508, 510; population of, I: 508; II: 606.

Lop, village, I: 400, 510.

Lop, Desert of, II: 113—114, 221—253; no dunes in, II: 66—67: ripple-marks in, II: 428—430: survey of, II: 234—253, 314—329.

Lopliks, I: 115, 457, 466, 478, Pl. 53: their canoes, I: 99: pursuits of, I: 229—230; II: 606.

Lop-nor, lake, old bed of, II: 63—66, 576 ff.: causes of its migrations, II: 357—366; hypsometrical relations of, II: 576 ff.: Lopliks' ignorance of, II: 140; old names of, II: 300—301; problem, II: 257—376.

*Lop-nor*, quoted, II: 36, 38, 43, 175.

Lôu-lan, altitude of, II: 584; ruins of, II: 613—644.

Lynxes, I: 71.

MacGregor, on sand encroachments, II: 407 n.

Mackinder, II: 366.

Maize, cultivation of, I: 7, 9, 17, 115, 375, 380, 428.

Maltak-kol, lakes, II: 572—573.

Mandl, II: 98.

Maps, Chinese, II: 277—297: D'Anville's, II: 374—375: isobathic, 282, 294—295, Pl. 35, Pl. 41, Pl. 45, Pl. 46, 46 *a*: native of Koral-dung, I: 109, 110; of Russian General Staff, II: 567.

Maral-baschi, population of, II: 605.

Marching, rate of, across Desert of Tschertschen, I: 313.

Marco Polo, II: 265, 301, 313, 405, 599.

Mardaktik, I: 462, 463

Mardak-köl, I: 463, 466; feeding canal of, I: 468.

Markat, depth at, I: 182.

Masars, I: 6, 46, 52, 55, 59—60, 63, 67, 71, 73, 83, 84, 92, 100, 102, 103, 105, 427, 435: of Habdan Busrugvar, I: 9; of Ikki Dschan Pena Masar Chodscham, I: 49; of Saj-tagh, I: Pl. 11.

Masar-chodscham, I: 59—60.

Masar-tagh, formation of, I: 34: view of, I: Pl. 6, Pl. 10 *a*.

Matussovskij, II: 96, 612.

Melons, grown, I: 49, 115, 375, 428.

Merdek-tarim. See Ilek.

Middendorf, von, II: 407.

Midges, I: 211.

Mill, H. R., II: 366.

Mines, gold, II: 93: lead, II: 74, 75, 86, 87, 93.

Mohn, II: 203.

Moldscha-darja, I: 373, 375.

Mollusc shells, I: 438; II: 56, 65, 128, 364, 455—457, 467, 469, Pl. 28: N. of Kara-koschun, II: 168; in Desert of Lop, II: 229—230, 238, 241—242, 246, 251, 638, 643; beside Ullugh-kol, I: 289.

Molun, probably wild-cat, I: 348; II: 128.

Mongols, in the Kuruk-tagh, II: 17, 22, 86.

Morgan, Delmar, his criticism of Author, II: 97, 259, 261, 265—268, 270, 306, 310.

Mosquitoes, I: 211, 375.

MSS., at Lôu-lan, II: 630.

Mudschi, population of, II: 604.

Muhamed Emin, of Tagirman, I: 486—487, 488.

Muschketoff, II: 269, 395, 407.

Mus-suji, of Tarim, I: 164—166; II: 541—545.

Naser Bek, I: 508—510; map by, I: 507.

Natives, of East Turkestan, I: 15, 436, 478; II: 613, Pl. 3, Pl. 5; of Al-katik-tscheke, I: 131: of Lajlik, II: 600: (Lopliks), I: 466, 509, Pl. 53: of Abdal, II: 509; of Jurt-tschapghan, I: 224: at Tschigelik-uj, I: 218.

Neumayr, on dune-formation, II: 413 f.

Nias Bek, lake, I: 187—188.

Nias-kol, view of, II: 347.

Nija, altitude of, II: 570; population of, II: 605.

Nija-darja, I: 79, 373; fall of, II: 570.

Nikitin, II: 96.

Nomenclature, domestic, I: 133—134; geographical, I: 14, 17, 18, 51, 53, 78, 92, 382—383, 414: II:

10—11, 18, 37—38, 63, 75, 77—78, 282—283, 291—292, 471—513; between Anambaruin-gol and Abdal, II: 471—472; of Kara-koschun, II: 211; of lakes, I: 281, 208—209, 306—308; of river phenomena, I: 199, 211.
Novot (irrigation law), I: 68—69.
Nukitu-daban, II: 277—278, 281—286.

Obrutscheff, on Asian lake depressions, II: 370—375; on Chara-narin-ula depression, II: 384; on Desert of Ordos, II: 382—383; on Kum-tagh desert, II: 384—387; on sand in Hwang-ho, II: 98, 396 f., 441, 447.
Ogen, I: 102. See Tarim.
Oj-toghrak, population of, II: 604.
Olun-temen-tu, etymology of, II: 72 n.
Olsson, Dr. K. G., and astronomical observations, II: 583.
Opghan-darja. See Lajlik-darja.
Ordan Padschah, sand encroachments at, II: 406, 407 n.
Ordos, Desert of, Obrutscheff on, II: 382—383; Potanin on, II: 379—382.
Orléans, Henri d', on Kara-koschun, II: 353 and II: 264, 271.
Ostracods, fragments of in sand, II: 455—456.
Otter-skins, as tribute, I: 499.

Partridges, I: 233.
Penck, on dune-formation, II: 412; on origin of dunes, II: 398, 400.
Peschel, on air-currents, II: 221, 398.
P'e-schan. See Bej-sàn.
Petrovskij, II: 600.
Pheasants, I: 71, 146, 348.
Piasetskij, II: 98.
Pjevtsoff, I: 66 f., 311, 402; II: 95, 97, 173, 176—199, 203, 205, 264 f., 269, 271, 275 f., 279, 209, 311, 358, 566, 567, 597, 611; on altitude of Ak-su, II: 566; on altitude of Chotan, II: 567; on altitude of Korla, II: 567; on altitude of Kutschar, II: 567; on desert lakes beside Tarim, I: 228; estimate of population of E. Turkestan, II: 611; on Jarkent-darja near Aksak-maral, I: 54 n.; on Kara-koschun, II: 175; up Kaschgar-darja, I: 100; on Kodaj-darja and Jarkent-darja, I: 38 n., 69 n.; on Lop-nor, II: 273—274, 298; on the Utschu-köl, II: 169; on the wild camel, I: 227.
Place-names. See Nomenclature.
Poplars, forests, II: 7, 8, 11, 15, 35; beside Astin-jol, I: 372, 375, 376, 381; beside Begelik-kol, I: 288; beside desert lakes, I: 242, 243, 255, 280; in Desert of Gobi, II: 490; in Desert of Lop, II: 224—230, 238, 240—243, 250, 626, 639; beside Ettek-tarim, I: 403, 404, 405—406, 412; beside E. Ilek, I: 406; beside the Ilek, I: 469—473; illustrations of, II: 440, 574; near Kara-koschun, II: 139—140; N. of Kara-koschun, II: 185; beside Kuruk-darja, I: 439; beside Schirge-tschapghan arm, I: 406, 451, 453, 454; in Tarim delta, I: 419, 420, 423, 424, 426, 430; beside Tschertschen-darja, I: 348, 383, 388, 391. See also Forests and Kotak.
Poplars, dead, N. of Kara-koschun, II: 168—169; beside old bed of Tarim, I: 438—439; in Desert of Tschertschen, I: 345.
Population of Ajsa-tscheke, II: 604; of Ak-su, II: 605; of Ala-ajghir, II: 604; of Avat I: 80; of Baj, II: 609; of Bughur, II: 609; of Chotan, II: 605; of East Turkestan, II: 608 ff; of Fajs-abad, II: 604; of Ghuma, II: 605; of Iltschi, II: 609; of Islamabad, II: 604; of Jangi-hissar, II: 605; at Jangi-su, I: 185, 403; of Jarkent, II: 605; of Jas-julghun, II: 604; at Jupogha, I: 7; of Jurt-tschapghan, II: 132; of Jurun-kasch, II: 609; of Kadike, II: 604; of Kalta-natschuk, II: 604; of Kan-arik, I: 7; II: 604; of Kara-kum, II: 604; of Kara-schahr, II: 609; of Karghalik, II: 605; of Kaschgar, II: 605; of Katschung, II: 604; of Kerija, II: 605; beside Kodaj-darja, I: 67; of Korla, II: 605; of Kum-tschapghan, II: 131—132; of Kutschar, II: 605; of Lop country, I: 508; of Maral-baschi, II: 605; of Mudschi, II: 604; of Nija, II: 605; of Oj-toghrak, II: 604; of Posgham, II: 604; of Psan, II: 604; of Sanguja, II: 604; of Schah-jar, II: 605; of Schinalgha, II: 604; of Simlik, II: 604; of Tschaj, I: 221; of Tschertschen, II: 605; of Tschigelik-uj, I: 218; II: 604; of Tschira, II: 605; of Tusun-tschapghan, II: 132; of Ullugh-kol, I: 168; of Utsch-turfan, II: 605; Pjevtsoff's estimate of in E. Turkestan, II: 613.
Porphyry, in Kuruk-tagh, II: 55; in Masar-tagh, I: 34.
Portage, names for, I: 140, 185.
Posgham, population of, II: 604.
Potanin, on Desert of Ordos, II: 379—382, 441 and 447, 499.
Pottery, found in desert, II: 58, 64, 620, 627 ff.
Prschevalskij, I: 268, 292, 300, 333, 414, 434, 441 f., II: 83, 102, 111, 131, 135, 139 f., 145, 162, 173, 175, 176, 178 f., 183, 187, 201 f., 207, 213, 222, 235, 259, 265 f., 268, 270 f., 273, 278 f., 280 f., 285, 289, 294 f., 297, 299, 304 f., 312 f., 356 f., 362, 368, 375, 380, 471, 504 f., 549, 551, 567, 579; on altitude of Chotan, II: 567; on Kara-buran, II: 100; on S. of Kara-koschun, II: 175; on the Kuruk-tagh, II: 97—100; on the Lop-nor, II: 261—262, 264; Tarim crossed by, I: 100.
Psan, population of, II: 604.

Rain, illustration of water flow from, I: 434; beside Bostan-toghrak, I: 381; in E. Turkestan, I: 116, 219; at Kara-koschun, I: 326; in Tarim delta, I: 422, 441.
Ramparts, of lower Tarim, II: 212—214.
Raskan-darja, II: 516—517.
Rats, in desert, I: 328, 333.
Ravens, I: 146, 147.
Reclus, II: 612.
Reeds, round Arka-kol, I: 480; beside Astin-jol, I: 372, 376, 380—381; in bajirs, I: 235; burning of, I: 477; in canal of Tuvadaku-kol, I: 181—183; dead stubble, I: 438—439; beside desert

lakes, I: 243, 280; in Desert of Lop, II: 69, 224—230, 238, 240, 251; used in building, II: 624 ff.; in Desert of Tschertschen, I: 328—330, 339; effect of in filling up lakes, II: 360 n.; beside Ilek, I: 484—485; in Kara-köl, I: 489; in Kara-koschun, II: 149; beside Kuruk-darja, II: 60; power of arresting sand, II: 159; between Sorun-kol and Tschol-köl, I: 43—44; beside Tarim, I: 87, 114; in Tarim, near beginning of desert, I: Pl. 21; in Tarim delta, I: 420—421, 442, 443; beside Tschertschen-darja, I: 223, 383, 386—387, 391.
Rémusat, *Hist. de la Ville de Khotan*, quoted, II: 264, 367.
Reservoir (köl), I: 9.
Rhins, J. L. Dutreuil de, II: 308, 311, 567.
Richthofen, von, I: 268; II: 4, 235, 262 f., 269 f., 277 f., 295, 298, 305, 309 f., 312, 366, 373; on aqueous and atmospheric deposits, II: 360 n.—361 n.; on the Han-hai, II: 307; on Lop-nor problem, II: 259—261, 267—268; on sand in steppes, II: 442—443; on wind-power in deserts, II: 454—455.
Ripple-marks, I: 353; II: 410—412, 428—435; and melting snow, I: 341; Cornish on, II: 410—411; Cholnoky on, II: 411—412; illustrations of, II: 428—429.
Ritter, II: 264.
Rivers and dunes, I: 411, 444—446.
River-beds, abandoned, names for, I: 14.
Roads, Abdal to Tscharklik, I: 224: Ak-su road, I: 49; the Astin-jol, I: 370, II: 493; to Astin-tagh, II: 216—218; to Avat, I: 58; Chotan to Ak-su, I: 80, 82; to Dung-chan, II: 147, 148; from Dural, I: 428, 435, 436; in Desert of Gobi, II: 475—476; from Jing-pen to Turfan-karaul, II: 38, 41; to Jing-pen, II: 11; Jing-pen to Turfan, II: 37; from Jupoga, I: 8; from Kakde I: 115; Kan-joli, I: 431; from Korla, I: 159; Lop-nor to Korla, II: 11, 15; to Maral-baschi, I: 12; old, through Kuruk-tagh, discovered, II: 107, 118; old, through Lôu-lan, II: 625, 633 ff., 638, 646; to Tschimen, I: 100; from Turfan, I: 509; Ustun-jol, II: 493.
Roborovskij, I: 345, 371, 384, 400; II: 3, 79, 98, 103 f., 110, 121, 173, 176, 266, 269, 285, 296, 309 f. 391 f., 396; on Desert of Ak-bel-kum, II: 389—390; on Desert of Kum-tagh, II: 387; on Kuruk-tagh, II: 100—102; journey of, in Kuruk-tagh, II: 93—96; his map criticised, I: 378, 380, 407; nomenclature of, I: 382—383, 398; old bed of Tschertschen-darja, I: 311, 312, 383.
Rock-crystal, II: 78.
Rohlfs, Gerhard, II: 436.
Rolland, on climate and dunes, II: 398; on desert dunes, II: 436 n.; on dune-distribution, II: 412—413; on dune-movements, II: 402 n.—403 n.; 406 n.—407 n.; on excavating power of wind, II: 460 n.; on Saharan dunes, II: 396—397.
Ruins, near Andere-terem, I: 377; at Jing-pen, II: 30—35; beside Tschertschen-darja, I: 388—389. See also Lôu-lan.
Russian General Staff, map of, II: 566, 567.

**S**adak-kol, I: 462—464; view of, II: 346.
Sahara, dunes of, II: 396—397.
Saj, landscape, II: 16; at foot of Kuruk-tagh, II: 52.
Saj-kol, I: 42—43; view of, I: 41.
Saj-tagh, strata of, I: 46; view from, I: Pl. 7, Pl. 8, Pl. 9, Pl 10*a*—*b*; view of, I: 41, 42.
Saksaul, II: 476, 484, 574.
Salt, in bajirs, I: 235; in Desert of Lop, II: 71; lowering temperature in desert, I: 340—341; in Tarim delta, I: 420; at Tusluk-tagh, I: 40.
Sand, analyses of specimens, II: 455, 462—470; currents of, II: 426; distribution of, in Desert of Tschertschen, I: 354—355; in gullies between jardangs, II: 240, 243: between Kodaj-darja and Kaschgar-darja, I: 69; movements of particles in dunes, I: 272—275; origin of in Tarim basin, II: 441—461; pressure of in Tarim basin, I: 302—303; ripples of, I: 353; waves of, I: 353—354; wave-movements of, II: 416—439. See also Dunes, Dune-accumulations and Storm.
Sand-storm, II: 47—48.
Sanguja, population of, II: 604.
Sate-köl, II: 146, 147, 149.
Satma, house, I: 127, 132—134; at Araltschi I: 396; at Sejt-kol, I: Pl. 30.
Schah-jar, population of, II: 605.
Schap, plant, II: 482, 484, 497.
Schejtler, I: 421, 423.
Schinalgha, population of, II: 604.
Schirge-tschapghan district, I: 214, 216, 450—451; channels in, I: 454—455, 457.
—, branch. See Tokus-tarim.
Schor, at foot of Kuruk-tagh, II: 53; in Desert of Lop, II: 242—245, Pl. 29.
Schori, Walther on, II: 440.
Schor-kol, lake, I: 35—38; its canals, I: 35—37.
Schudang, views of, I: 376.
Schuei-king-tschu, II: 287—288.
Secular elevation of Scandinavia, I: 302.
Sedge (*jäkan*), I: 220, 256, 280, 421, 449; II: 147, 149; seed of, I: 485.
Sejt-kol, I: 229—230, 255, 298, 304: deserted huts at, I: Pl. 30; loop at, I: 160; views of, I: Pl. 38, 39, 40, 43.
Sejt-uj, channel, I: 209.
Serai, at Kan-arik, I: 8.
Shaw, II: 260.
Sheep, I: 40, 70, 88, 91, 94, 96, 103, 107, 115, 116, 218: II: 6, 139; breeding of, in East Turkestan, II: 605; disease of I: 115—116.
Shepherds, of East Turkestan, II: 606—607; huts of, I: 37, Pl. 12; beside the Jarkent-darja, I: 16, 17, 36, 74; beside Tarim, I: 91, 97.
Sil, (overflow), II: 14, 14 n.
Simlik, population of, II: 604.
Singer, village, II: 87, 92.
*Si-yu-schuei-tao-ki*, quoted, II: 276—278, 284.
Small-pox, I: 127, 229, 233.
Snow, beside Bostan-toghrak, I: 381; at confluence of Chotan-darja, I: 87; in Desert of Tschertschen, I: 336—346, 387, 389, 392, 393; at Kakde,

I: 116; in Kuruk-tagh, II: 35. 108; on Saj-tagh, I: 42; in Tarim delta. I: 422, 467.
Soghot, Kosloff's, I: 477.
Sokolow, II: 392. 396, 400, 407; on dunes, II: 403. 408—409, 414—416; on River Don sands, II: 446.
Sollak-akin, I: 477—478.
Sor-sure, altitude of, II: 580.
Sorun-kol, I: 43.
Sosnovskij, II: 98.
Sound (*bolto*), in lakes, I: 252, 254, 255.
Soundings, in Begelik-köl, I: 288. 294—297. Pl. 46, 46*a*; deepest in Lop country, I: 182, 482; in desert lakes, I: 264, Pl. 41; of Karaunelik-kol, I: 254, 258—296, Pl. 41, Pl. 46*a*; of Toghraklik-kol, I: Pl. 41; of Ullugh-kol, I: 282. 283, 296, Pl. 45, Pl. 46*a*.
Spiders, II: 75.
Springs, in Kuruk-tagh, II: 54. 74—76, 77—78, 82, 83, 84, 86, 87, 88, 90. 110—121.
Stein, Dr, I: 378; II: 367, 406, 567; on altitude of Chotan, II: 567 n.; on Kerija-darja, I: 70 n.; II: 309, 349—350.
Stieler, II: 96, 307.
Stoliczka, II: 443.
Storm, dust (*kara-buran*), I: 223, 289—293; sand, II: 47—48.
Stubendorff, II: 274, 278 f.
Suget, bush, II: 17.
Suji-sarik-kol, I: 486, 487; tschapghan of, I: 484—485.
Sultan Kara Sakal Attam, view of, I: Pl 8, Pl. 10*a*—*b*.
Surveying, of Desert of Lop, II: 234—253. 314 320.
Supan, II: 397, 612; on dune-formation, II: 413—414; on Kara-koschun, II: 361 n.; on wave-movement, II: 425, 428.
Swans, wild, I: 44, 233, 440.
Széchenyi, Béla, II: 395, 407, 443.

Tagh-kum, I: 406—410; view of, I: 405, 407.
Tais-köl, I: 289, 294, 295; II: 147.
Tajek-köl, I: 482—484, 486, 494; II: 304—305, 331—335, 341—346; altitude of, II: 581; depth of, II: 580.
Takla-makan, Desert of, II: 221; bajirs in, I: 364; compared with other deserts, II: 306—308; dune. in, I: 364; between Terem and Lajlik, I: Pl. 2s
Takyr, Walther on, II: 440.
Tal, tree, II: 17.
Talaschti-kol, I: 289, 299, 306.
Talei Kullu-tschapghan, I: 232, 306, Pl. 43.
Tamarisks, beside Astin-jol, I: 372, 374, 375, 380; at end of Basch-kol, I: 234; beside desert lakes, I: 243; in Desert of Gobi, II: 400—402; in Desert of Lop, II: 58—59, 61, 224—231, 238, 240—242, 250; in Desert of Tschertschen, I: 334, 339, 347—348; beside Ettek-tarim, I: 415; mounds of, I: 342; II: 12, 15—16; mounds, in Arka-kol, I: 480; mounds in Kara-koschun, II: 136; in Gölme-kati, I: 239; to N. of Kara-koschun, II: 126—127, 170, 180; and sand-dunes, I: 387—388, 401. See also Kouruk.
Tana-baghladi-kol, I: 232, 298, 306, 318, Pl. 43.
Tarim, general view of its system, II: 515—528; characteristics down to Karaul, II: 529—540; from Karaul to Kara-koschun, II: 540—552; altitudes of, II: 588, 590, 592—596; delta of, II: 153—157, 330—352, 594; at Basch-arghan, I: 416; at confluence of Chotan-darja, I: 84—85; below same, I: 86; confluence with Ugen-darja, I: Pl. 56; at entrance into desert, I: 120, 121, 122, Pl. 23; at Intschkä-dige-tam, I: Pl. 29; in Kara-buran, II: 198—200; below Katschik, I: 119; at Kalmak-kum, I: 213; at Schirge-tschapghan, II: 551; bank of at Tokus-kum, I: 127; at Tschigelik-uj, I: 217; above Tokus-kum, I: 129, Pl. 24, Pl. 32, Pl. 33; known as Jumalak-darja, I: 113, 117, 120, Pl. 20, Pl. 21; basin, area of, II: 524; basin of, compared with basin of Tsajdam, II: 369—370; basin, circulation of dust in, I: 291—293; basin, hypsometrical relations of, II: 565 f., 584; basin, origin of sand in, II: 441—461; basin, pressure of sand, I: 302—303; bed of in Desert of Lop, II: 227; breadth, II: 558—561; changeability of, I: 95, 106—107, 128—129, 159, 175, 188, 456; compared with Kuntschekisch-tarim, I: 431—432; depths, II: 558—561; dimensions, II: 558—561; at Busuk, I: 86—87; at Intschkä, I: 96; at Peres, I: 100—101; at Tupe-teschdi, I: 105; at Koral-dung, I: 112; at Sadik-bajning-arighi, I: 124; at Al-katik-tscheke, I: 136; at Siva, I: 141; at Karaul, I: 152; at Jangi-kol, I: 162—165, 260; at Kirtschin, 177, 260, 286; of Old Tarim, I: 184, 189, 190; at Arghan, I: 193, 260; at Almontschuk, I: 208; at Schirge-tschapghan, I: 214—215, 217, 260; at Tschigelik-uj, I: 217; below Tschertschen confluence, I: 224; at Karaunelik-kol, I: 456; at Jurt-tschapghan, II: 152—153, 161—164, 204—205; at Kum-tschapghan, II: 153—156, 162—164; at Tusun-tschapghan, II: 153—158, 161—164; drift-ice on, I: Pl. 23; and dune-accumulations, I: Pl. 48; erosive action of, I: 88—90, 93, 98, 138—139, 195—205; fall of, I: 351; II: 569 ff.; fluctuation of level, II: 205, 541—545; freezing on banks, I: 104; length of, II: 575; marginal lagoons, I: 109—112; map isobathic, at Arghan, I: Pl. 35; maps native, around Koral-dung, I: 109, 110; navigation of, I: 139—140; Ogen-darja rejoins it, I: 118; oscillations of volume, I: 260; II: 353—354; oscillatory movements of, II: 363; lower, ramparts of, II: 212—214; relations to Daschi-kol, I: 308; relations to desert-lakes, I: 179, 300; relations to Ettek-tarim, I: 405—406, 408; relation to Karaunelik-kol, I: 258—262; relations to Kontsche-darja, I: 302; relations to Ugen-darja, I: 151 ff.; relations with Ullugh-köl, I: 285—287; in sandy desert, I: Pl. 22, Pl. 26; view above Jurt-tschapghan, II: 151; view of at Koral-dung; I: Pl. 18; view at Sejt-köl, I: Pl. 38; view at Tschong-otak, I: Pl. 19, Pl. 20; view at confluence with Ugen-darja, I: Pl. 28; volume comparative, I: 125; volumes, table of, II: 558—561; scenery above Busrugvar, I: 139; statistics of transparency etc., II: 553—556; velocities, table of, II: 558—561.

Tatlik-kuduk, altitude of, II: 579.
Tatran, I: 311, 312, 369.
Tauschkan-darja, II: 523.
Teis-köl, I: 298, 307.
Temperature, of air, in Desert of Gobi, II: 491; in Desert of Lop, II: 160, 232; in Desert of Tschertschen, I: 381, 391, 414; at Haradighan-kötäk, II: 591; at Jing-pen, II: 37; at Lajlik, II: 591; at Modsche — toghrak, II: 591; at Suget-bulak, II: 19.
—, of water, in Begelik-köl, I: 289; in Desert of Lop, II: 232; in Desert of Tschertschen, I: 318, 332, 340; if Jarkent-darja, I: 81; in Kara-koschun, II: 146; N. of Kara-koschun, II: 181, 188; of Kontsche-darja, II: 10; in Kuruk-darja, II: 47, 53; in Kuruk-tagh, II: 119; of Tarim, I: 456; of Ullugh-kol, I: 285.
Temple, ancient, in desert, II: 640 ff.
Tengeri, Desert of, II: 380—381.
Terem, I: 102. See Tarim.
Teresken, II: 473.
Terns, I: 128, 256.
Terraces, clay, beside Astin-jol, I: 370; in bajirs, I: 317; beside Kuruk-darja, II: 47, 49, 51, 55, 57; in dunes, I: 271—272, 275.
Teschikans, rodents, II: 19.
Thresholds, between bajirs, I: 314, 316, 318, 319—320; camels resting on, I: 318; dunes on, I: 315; and dune-accumulations, I: 356—362, Pl. 52.
Ticks, II: 75.
Tien-schan, names of, II: 97.
Tigers, I: 18, 40, 54, 80, 115, 389, 400, 495; and ants, II: 138—139; trap for, 107—108.
Tikenlik, I: 428, 429.
Timber, floated down Ak-su-darja, I: 71; supply of, in Lop country, II: 135; at Lôu-lan, II: 619 ff.
Toghraks. See Poplars and Forests.
Toghrak-kuduk, II: 496—497.
Toghraklik-kol, I: 252, 298, 307, Pl. 43; and its bajirs, 265—267.
Toghrak-tscheke, I: 470, 472, 473.
Tojaghun, lake, II: 139, 141—143.
Toktasin Bek, I: 399, 400, 403, 405.
Tokus-kum, I: 130, 131, Pl. 32, 33; view of, I: Pl. 24.
Tokus-tarim, I: 441—448, 497; II: 209—211, 215, 275, 550—551; altitude of, II: 593; as barrier against sand, II: 339; continuation of, II: 128, 167, 169; dimensions of, I: 444—445; at Schirge-tschapghan, I: 260, 406; views of, I: 444, 448.
Tollan-chodscha, I: 373, 379, 380; valley of, II: 456.
Tor, bird-trap, I: 50; fish-trap, I: 83, 92, 93, Pl. 16.
Toras, of Jing-pen, II: 31, 33; at Lôu-lan, II: 619 ff.
Torguts (Mongols), II: 86.
Torpak-oldi, Tschernoff's sketch of, II: 507.
Tosak, trap for tigers, I: 107—108.
Toschkan-darja, I: 78.
Tosghak-tschantschdi, village, I: 477, 481.
Tower, near Andere, I: 377; at Jing-pen, II: 31, 33; at Lôu-lan, II: 619 ff.
Transparency, of river, how determined, I: 27; of Tarim, table, II: 553—556.
Traps for birds, I: 50; for fish, I: 83, 92, 93, Pl. 16; for tigers, I: 107—108.
*Trudij Espeditsij*, quoted, II: 4, 30, 85—91, 101—102, 174—175.
*Trudij Tibetskoj Ekspeditsij*, quoted, I: 38 n., 66 n., 227—228, 312 n.; II: 93—94, 611.
Tsajdam, basin of, compared with basin of Tarim, II: 369—370.
Tscha-jan. See Intschkä-darja.
Tschakende, bush, II: 73, 120, 474.
Tschang-tsen, quoted, II: 263—264.
Tschapghans, or reed-channels, I: 186, 189, 220; II: 136—139; at Suji-sarik-kol, I: 484—485.
Tscharajlik-tagh, I: 86, 89, 91.
Tscharklik, I: 461; altitude of, II: 570.
Tscharklik-su, I: 398; fall of, II: 571.
Tschernoff, his expedition, II: 471—514.
Tschertschen, Desert of, II: 221; altitudes in, II: 572, 576 ff.; animals in, I: 328, 333; bajirs of, I: 311—369, 315, 316; clay formations in, I: 317, 322, 323; compared with Desert of Kum-tagh, II: 309; conformation of, I: 315; day-fly in, I: 324; dead poplars, I: 345; distribution of bajirs, I: Pl. 52; distribution of sand in, I: 354—355; dune-systems, I: 360—362; views in, I: 318, 338, 341—343, 346, Pl. 50, 51; laws of dune-accumulations, I: 362; reeds in, I: 235, 328—330; situations of dune-accumulations, I: Pl. 52; snow in, I: 336—346; temperature of water in, I: 318, 332, 340; thresholds, between bajirs, I: 314, 316, 318, 319—320; vegetation in, I: 235, 328—330, 334, 339, 345, 347—348; wind in, 316, 319, 320—321, 332.
Tschertschen, town, I: 369, 371; altitude of, II: 570; population of, II: 605.
Tschertschen-darja, I: 369, 382—402, II: 309; at Ak-ilek, II: 519; dimensions of, I: 222; drainage-basin of, II: 523; fall of, I: 351, 384; II: 570 ff.; dunes beside, I: 394; ice on, I: 348, 382—387, 396; old beds of, I: 383—388, 399; Roborovskij's old bed of, I: 311, 312, 383; views of, I: 221, 223, 384—387, 391, 393, 394, 397.
Tschige, serub, I: 334, 370, 371, 392; II: 6.
Tschigelik-uj, I: 217—219; population of, II: 604.
Tschimen, road to, I: 100; crossing river at, I: 100.
Tschimen-kol, I: 281.
Tschindejlik, altitude of, II: 579.
Tschira, population of, II: 604.
Tschivilik-kol, I: 421, 486—487, 491, 492—493, 497, 499, Pl. 55, II: 305, 345, 347; depth of, II: 580.
Tschoka-tagh, I: 43, 45; I: Pl. 8, Pl. 9, Pl. 10 *b*; author's excursion across, I: 45; profile of, I: 46.
Tschol-köl, I: 43—46.
Tschöl-ottogho-tarim, I: 430.
Tschöl-tagh, II: 79—80, 85, 87, 91, 98, 102.
Tschong-kol, lake, I: 459, 468.
Tschong-otak, view of, I: Pl. 19, Pl. 20.
Tschong-tarim, I: 191, 194, 203, 425.
Tschutschun, plant, II: 119.
Tuge-tau, II: 80, 81, 83, 91.
Tungans, or Dungans, I: 427, 429, 508; II: 5, 86, 87.
Tura-salghan-uj. See Jangi-kol.
Turfan-karaul, ferry at, II: 519; road to from Jing-pen, II: 38, 41.

Turkestan, East, agriculture in (see Agriculture); Bogdanovitsch on its hydrography, I: 78; deserts of (see Lop, Takla-makan, Tschertschen, etc.); fall of, II: 565 ff., 584; fishing in, I: 35, 36, 115, 126, 134—135, 137, 140, 280, 477, 479; II: 606, 642; hunting in, I: 134, II: 606; hydrography of (see Ak-su-darja, Chotan-darja, Ilek, Jarkent-darja, Kodaj-darja, Kuruk-darja, and Tarim); irrigation in (see Irrigation); natives of, I: 15, 131, 218, 224, 436, 466, 478, Pl. 3, Pl. 5, Pl. 53; II: 598—601 (see also Population); population of, II: 597 ff., 613; occupations in, II: 597 ff., 603, 606; rain in, I: 116, 219, 326, 381, 422, 441; sand (see Dunes and Sand); sheep-breeding in, II: 604, 605 (see Sheep); temperature (see Temperature); wind in (see Winds).
Turkomak, bush, II: 147.
Turkomak-kol, II: 144—145.
Turkomakte-kok-alasi, I: 505, 508; II: 549.
Tus-alghutsch-kol, lake, I: 228—229, 298; view of, I: Pl. 42.
Tusluk-tagh, view of, I: Pl. 9, Pl. 10 *a*.
Tusun-tschapghan-arm, II: 153—155, 160, 163—164.
Tuvadake-kol, I: 289, 294, 295.

Ugen-darja, confluence with Tarim, I: Pl. 56; dimensions of, I: 152—153; its hydrographical relations, I: 149—157; mouth of, I: Pl. 27; views of, II: 538, Pl. 28, Pl. 56.
Ujlik, meaning of, I: 428 n.; II: 601.
Ullugh-kol, I: 178—179, 277—287, 208, 304, 307, Pl. 43; II: 344; compared with Karaunelik-köl, I: 284—285; dimensions of, I: 299; fishing in, I: 280; isobathic map of, I: Pl. 45; relations with Tarim, I: 285—287.
Uspenskij, V. M., II: 277, 281, 285.
Ustün-jol, II: 493.
Usun-kol (Kara-koschun), II: 139, 141, 143—144.
Utsch-turfan, population of, II: 603.
Utuschu-kol, II: 169.

Vaccination, for small-pox, I: 230.
Vegetation. See Kamisch, Poplars, Tamarisks, Köuruk, Jantak, Jigde, etc.
Velocity instrument, I: 28.
Villages in East Turkestan, II: 598—601.
Volume, of Ak-su-darja, I: 125; of Tarim, table, II: 558—561; below Arghan, I: 194—195; of Tarim at Kirtschin, I: 178—179; of Tarim at Sadik-bajning-arighi, I: 125; of Toschkan-darja, I: 125.

Wagner, II: 610.
Wagtails, I: 256, 280.
Walther, J., on binding power of vegetation, II: 360 n.—361 n.; on deserts of Amu-darja and Sir-darja, II: 444—446; on dune-formation, II: 415; on Kara-kum desert, II: 415; on origins of drift-sand, II: 442; on salt and snow in desert, I: 341; on takyr and schori, II: 440; on Trans-Caspian dunes, II: 404 and II: 407, 448, 454.
Water formations, native names for, I: 18; wave-movements of, II: 407, 416—428, 448, 454.
Water-lilies, I: 182, 187, 190 and 190 n.
Waves, action of in Golme-käti, I: 241; movements of, in sand etc., I: 353; II: 411—439.
Wegener, II: 277, 280 f.
Wells, beside Astin-jol, I: 371—372; beside Ettek-tarim, I: 404; at Kara-kum-kuduk, I: 9; at Mahametning-kudughi, I: 9.
Wheat, cultivation of, I: 17, 49, 53, 71, 74, 75, 104, 115, 190, 375, 376, 380, 421, 428, 503; II: 37.
Wiklund, Dr., transcription method, II: 660.
Wild boar, I: 26, 48, 71, 233, 235, 256, 280, 380, 440, 495; II: 86, 128, 131, 138, 180.
Wild camel, I: 144, 227, 289, 466—467; region of, II: 52, 53, 75—77, 112, 113, 119, 185.
Wild-cat, II: 128.
Wild-duck, I: 26, 44, 57, 233, 348, 423, 440, 483; II: 36, 45, 127, 128, 130, 138, 171, 180.
Wild-geese, I: 57, 440; II: 36, 127, 128.
Wild-swans, II: 127, 128.
Wilkins, II: 96.
Willows (*suget*), I: 62.
Wind, in desert lake region, I: 240—241, 247—251; and drift-sand, I: 254; effect of upon shaping bajirs, I: 248—250; effects of in Desert of Lop, II: 238, 247—249, 362—366; effect of, upon dune-accumulations, I: 270—275, 277—278; effect of on dune-formation, II: 439, 448—462; excavating power of in Desert of Lop, II: 67; and ripple-marks, II: 430—431; transporting power of, I: 291—293; II: 132—134; Lóczy on agency of, II: 488—489.
Winds, in Central Asian desert, I: 364; in Desert of Tschertschen, I: 316, 319, 320—321, 332; beside Kara-muran, I: 375; paths of in East Turkestan, II: 334—335; prevailing, in Lop country, I: 351, Pl. 52. See also Wind.
*Windstauung*, I: 342.
Wolves, I: 26, 332, 348.
Wood-carvings, at Lôu-lan, II: 619 ff.

Yule, Sir Henry, II: 267 f.

Zittel, on desert dunes, II: 436 n.

# ILLUSTRATIONS.

## *Full page Plates.*

Page
Pl. 3. Dry watercourse at Altmisch-bulak . . . . . 75.
3. Ice-sheet in watercourse below the spring Altmisch-bulak . . . . . 75.
4. Camp CLIV, Feb. 23rd 1901 . . . . . 80.
4. Wild camel shot at Altmisch-bulak . . . . . 80.
6. Camp CXLI, Feb. 8th 1901 . . . . . 104.
7. Looking west from Camp CXLI; Kuruk-tagh terrace in background . . . . . 106.
8. Summit of pass (1535 m.) Feb. 11th 1901 . . . . . 108.
8. Southern entrance to glen leading up to same pass . . . . . 108.
9. On plateau of Kuruk-tagh . . . . . 110.
9. Approach to pass partly sanded up (Feb. 11th 1901) . . . . . 110.
10. Scanty reeds at Camp CLIII (Feb. 22nd 1901) . . . . . 118.
10. Dense tamarisk thicket at same Camp . . . . . 118.
11. One of the small oases at northern foot of Kuruk-tagh . . . . . 120.
12. Inhabitants of Jurt-tschapghan (Abdal) . . . . . 156.
13. Western shore of new desert lake north of Kara-koschun. Camp CLXVI . . . . . 172.
13. After finish of levelling of desert on northern shore of Kara-koschun . . . . . 172.
14. Entirely newly-formed desert lake, March 28th 1901 . . . . . 178.
14. Attempt to dig out an old sanded up canoe . . . . . 178.
15. Camp CLXX. An old river-bed still full of water, on northern shore of Kara-koschun 184
16. View across a part of newly-formed desert lake between Kara-koschun and Lop-nor 186.
17. Looking east across Kara-koschun from Camp CLXXIV . . . . . 194.
19. Southern edge of Altmisch-bulak. Ice-sheets in bed of stream . . . . . 222.
20. Camp amongst thickets of Altmisch-bulak. Men cleaning skeleton of wild camel 230.
21. Camp CLVI at newly discovered spring south of Altmisch-bulak . . . . . 232.
22. Oasis at Camp CLVI . . . . . 232.
22. Watercourse filled with ice from same oasis . . . . . 232.
24. View across ruins of Loú-lan, looking S. 60 W. from top of tower . . . . . 238.
25. Looking S. 60° E. from top of tower . . . . . 238.
26. Looking S. 70° W. from top of tower . . . . . 238.
27. Small barren jardang ridges . . . . . 238.
28. Specimens of mollusc shells from desert of Lop . . . . . 246.
29. Bed of old watercourse through middle of desert of Lop . . . . . 248.
30. My caravan during levelling expedition. Taken in middle of desert of Lop . . . . . 250.
43. Sologhas, a small oasis south-east of Karghalik (see vol. IV) . . . . . 390.
45. Dunes in middle of desert of Gobi, 30th January 1901 . . . . . 410
46. Camp CXXXV, in middle of sandy desert, Jan. 30th 1901 . . . . . 414.
47. Left side of glen that debouches upon sandy desert, at Camp CXXXIV . . . . . 422.
47. Bush of saksaul, immediately outside same glen . . . . . 422.
48. Continuations of same glen in desert, views taken between Camps CXXXIV and CXXXV . . . . . 430.

Page
Pl. 49. Northern part of sandy desert, 31st Jan. 1901 . . . . . 438.
49. Marching between high dunes . . . . . 438.
50 a. Views from desert of Gobi . . . . . 446.
50 b. Dunes on the eastern shore of Nias-kol . . . . . 450.
50 b. Dunes in the heart of the Takla-makan desert . . . . . 450.
50 b. Dunes in the Kerija desert . . . . . 450.
52. Views from belt of steppe between Astin-tagh and desert range . . . . . 470.
53. Little oasis just above Camp CXLII. Feb. 10th 1901 . . . . . 478.
53. Southern part of Kuruk-tagh . . . . . 478.
54. Gigantic mass of bedded clay in desert between Camp CXXXVIII and Atschik-kuduk, Feb. 5th 1901 . . . . . 486.
54. Clay terraces on right side of our route between Camp CXXXVI and Camp CXXXVII, Feb. 1st 1901 . . . . . 486.
55. Masses of clay resembling ruined towers and walls between Camp CXXXVIII and Atschik-kuduk . . . . . 494.
56. Camp CXXXVIII. Camels drinking at recently dug well . . . . . 502.
62. View from roof of our seraj at Tscharklik . . . . . 606.
64. Solitary tower of March 3rd 1901 . . . . . 614.
64. Cloud of dust raised by demolition of upper part of tower — tower *A* at Loû-lan 614.
65. Tower at Camp CLIX, looking north-west . . . . . 622.
66. Wheel of arba and various fragments of carved wooden ornaments. Jardang ridges in background . . . . . 626.
68. House D looking south-south-east . . . . . 630.
69. Pulling down a dangerous mass at side of tower, Loû-lan . . . . . 632.
70. House F, south-west of manuscript house. Men excavating. In foreground big eartenware jar . . . . . 634.
71. Another view of house F . . . . . 636.
72. House M, giving an excellent idea of how these buildings at Loû-lan were constructed of poplars and sheaves of kamisch and tamarisk standing on end . . 638.
73. House of sun-dried bricks in Loû-lan, in third section of which, farthest on right, all the old chinese manuscripts were found . . . . . 640.
74. Tower of March 7th . . . . . 642.
74. Largest house in most north-westerly village of Loû-lan. March 7th . . . . . 642.
76. Excavating little »temple» in most north-westerly village of Loû-lan . . . . . 644.

### *Figures in the text.*

Fig. 1. The Toghrak-bulak or Astin-bulak . . . . . 3.
2. At Dilpar . . . . . 5.
3. Another view of Dilpar . . . . . 6.
4. Vertical section of the Kontsche-darja. The left bank is high, the right low . . 7.
5. Forest at Dilpar . . . . . 7.
6. Vertical section of Kontsche-darja at Dilpar, March 6 . . . . . 8.
7. Measuring the Kontsche-darja through holes in the ice . . . . . 9.
8. The migrations of the Kontsche-darja . . . . . 12.
9. Tamarisk-mounds between the Kontsche-darja and Basch-toghrak . . . . . 12.
10. Basch-toghrak . . . . . 13.
11. » . . . . . 14.
12. Vertical section at Basch-toghrak . . . . . 15.
13. Formation of tamarisk-mounds . . . . . 15.
14. Mountain scenery on the road between Suget-bulak and Kurbantschik . . . . . 19.

Page
Fig. 15. Mountain scenery on the road between Suget-bulak and Kurbantschik . . . . 20.
16. Mountain scenery on the road between Suget-bulak and Kurbantschik . . . . 21.
17. Ravines in the foothills near Kurbantschik . . . . . . . . . . . . . . . . 22.
18. Our Camp at Kurbantschik . . . . . . . . . . . . . . . . . . . . . . 23.
19. Kurbantschik; the deep basin in the foreground . . . . . . . . . . . . . . 24.
20. Scenery in the valley S.E. of Kurbantschik . . . . . . . . . . . . . . . . 25.
21. Scenery in the valley S.E. of Kurbantschik . . . . . . . . . . . . . . . 25.
22. Scenery in the valley S.E. of Kurbantschik . . . . . . . . . . . . 26.
23. Scenery in the valley S.E. of Kurbantschik . . . . . . . . . . . . . 26.
24. Broad parts of the valley S.E. of Kurbantschik . . . . . . . . . . . . . . 27.
25. Broad parts of the valley S.E. of Kurbantschik . . . . . . . . . . . . . 27.
26. Toghrak-bulak or Astin-bulak . . . . . . . . . . . . . . . . . . . . . 28.
27. The vertical section of a mountain slope . . . . . . . . . . . . . . 29.
28. The same . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 29.
29. The toras at Jing-pen . . . . . . . . . . . . . . . . . . . . . . . . . 31.
30 *a*. Ruins at Jing-pen . . . . . . . . . . . . . . . . . . . . . . . . . . 31.
30 *b*. The same . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 32.
31. Clay pot from Jing-pen . . . . . . . . . . . . . . . . . . . . . . . . 32.
32. Ruin at Jing-pen . . . . . . . . . . . . . . . . . . . . . . . . . . . 32.
33. The same . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 33.
34. Clay pyramid near Kalta . . . . . . . . . . . . . . . . . . . . . . . 33.
35. »Kurghan« between Kalta and Ju-jing-pen . . . . . . . . . . . . . . . . . 34.
36. Verttcal section of the Kuruk-darja . . . . . . . . . . . . . . . . . . . 36.
37. Part of the circular wall or old fort at Jing-pen. — as drawn in 1896 . . . . . 39.
38. Part of the old fort of Ju-jing-pen, as drawn in 1900 . . . . . . . . . . . . 39.
39. The ruins of Ju-jing-pen, as drawn in 1896 . . . . . . . . . . . . . . . . 40.
40. The country between Kuruk-tagh and Kuruk-darja east of Jing-pen . . . . . . 44.
41. The country between Kuruk-tagh and Kuruk-darja east of Jing-pen . . . . . . 45.
42. Terrace formations at the south foot of the Kuruk-tagh . . . . . . . . . . . 46.
43. Clay terrace at the south foot of the Kuruk-tagh . . . . . . . . . . . . 47.
44. Right bank of the Kuruk-darja . . . . . . . . . . . . . . . . . . . . . 48.
45. A labyrinth of clay-terraces . . . . . . . . . . . . . . . . . . . . 49.
46. Part of the desert north of the Kuruk-darja . . . . . . . . . . . . . . . 50.
47. The depression between the two terraces and the Kuruk-darja . . . . . . . 51.
48. A broad gully between the jardangs . . . . . . . . . . . . . . . . . . . 53.
49. On the southern slope of the eastern Kuruk-tagh . . . . . . . . . . . . 54.
50. Vertical section not far from Jaka-jardang-bulak . . . . . . . . . . 55.
51. Camping between the jardangs . . . . . . . . . . . . . . . . . . . 56.
52. Old tamarisks on the bank of the Kuruk-darja . . . . . . . . . . . . . 58.
53. A jardang and a piece of dead tamarisk in the desert north of Kuruk-darja . 59.
54. In the Kuruk-darja . . . . . . . . . . . . . . . . . . . . . . . . . . 60.
55. Vertical section of the Kuruk-darja . . . . . . . . . . . . . . . . . . 61.
56. Effects of refraction . . . . . . . . . . . . . . . . . . . . . . . . 62.
57. On the northern bank of the Kuruk-darja . . . . . . . . . . . . . . . . 62.
58. Vessels found on the banks of the Kuruk-darja . . . . . . . . . . . . . . 64.
60. In a gully between two jardangs . . . . . . . . . . . . . . . . . . . 65.
61. Vertical section of jardangs . . . . . . . . . . . . . . . . . . . . . 66.
62. Kamisch stubble in the desert . . . . . . . . . . . . . . . . . 69.
63. Kamisch in a lake . . . . . . . . . . . . . . . . . . . . . . . . . 70.
64. Formation of a jardang by a poplar . . . . . . . . . . . . . . . . . . 71.
65. Different stages in the clay terraces . . . . . . . . . . . . . . . . . 72.
66. Vertical section between Camps XII and XIII . . . . . . . 72.

Page.
Fig. 67. Vertical section of Altmisch-bulak . . . . . 74.
68. Wounded wild camel at Altmisch-bulak . . . . . 75.
69. Wounded wild camel at Altmisch-bulak . . . . . 76.
70. Another view from Altmisch-bulak . . . . . 77.
71. Clay terrace of Kuruk-tagh . . . . . 104.
72. Vertical section of the entrance to the glen . . . . . 106.
73. Fragments of iron pot found in the lower Kuruk-tagh . . . . . 107.
74. A cairn on the old road . . . . . 108.
75. The same as fig. 73, reconstructed . . . . . 109.
76. Vertical section of the mountain-chain . . . . . 109.
77. A little range of the Kuruk-tagh . . . . . 110.
78. Clay formations . . . . . 114.
79. Jardangs . . . . . 115.
80. Vertical section of rocks . . . . . 117.
81. The Kuruk-tagh with the entrance to the valley of Suget . . . . . 121.
82. Vertical section of the shore at Camp XXI . . . . . 125.
83. Old bed of the Tarim . . . . . 128.
84. Old bed of the Tarim north of Kara-koschun . . . . . 131.
85. Effect of the drift-sand upon the Kara-koschun . . . . . 133.
86. Sandfields north of Kara-koschun . . . . . 134.
87. A small open »köl» in the kamisch of the western Kara-koschun . . . . . 137.
88. Tschapghan in the Kara-koschun . . . . . 138.
89. A »tschapghan» in the Suji-sarik-köl . . . . . 138.
90. Showing the relative depth of Tojaghun . . . . . 142.
91. The same . . . . . 142.
92. The eastern part of Kara-koschun, as seen from a mound on the northern shore, in 1896 . . . . . 145.
93. Difference of depth in the southern and northern part of Kara-koschun . . . . . 146.
94. Presumptive and real section of Kara-koschun . . . . . 147.
95. The Tarim a short distance above Jurt-tschapghan . . . . . 151.
96. Vertical section at Jurt-tschapghan, April 13 . . . . . 152.
97. Vertical section of Tarim at Kum-tschapghan, April 10 . . . . . 153.
98. The Kum-tschapghan and Tusun-tschapghan anno 1900 . . . . . 153.
99. Vertical section of Tusun-tschapgan branch, April 10 . . . . . 154.
100. Vertical section of Kum-tschapghan branch, April 10 . . . . . 154.
101. Distribution of water in the Kara-koschun . . . . . 155.
102. View to the east from the top of the highest dune-mound at Kum-tschapghan. This is the real delta, where the Tarim dissapears in the marshes of Kara-koschun (drawn in 1896) . . . . . 156.
103. View to the N.W. from the same point . . . . . 157.
104. View to the south from the same point. In the foreground the satmas of Kum-tschapghan and behind them the very end of the Tarim river . . . . . 157.
105. Vertical section of Tarim at Jurt-tschapghan, June 25 . . . . . 158.
106. Vertical section of Tarim and Kara-koschun . . . . . 158.
107. The lowermost Tarim acting as a reservoir for the summer water . . . . . 159.
108. Vertical section of Tarim at Jurt-tschapghan, April 3 . . . . . 161.
109. The chinese fort of Jurt-tschapghan . . . . . 162.
110. View to the east, April 1st; part of the new lake north of Kara-koschun . . . . . 165.
111. Part of the new lake to the north of Kara-koschun (1900) . . . . . 166.
112. Probable conture of the north-east of Kara-koschun . . . . . 172.
113. A piece of board . . . . . 178.
114. The huts at the present time . . . . . 178.

Page.
Fig. 115. The huts when still inhabited . . . . . 179.
116. Vertical section of the shore region . . . . . 179.
117. Vertical section of old river-bed . . . . . 180.
118. The hut on the northern shore of the lake . . . . . 181.
119. The bedding of the clay . . . . . 186.
120. The same . . . . . 195.
121. Vertical section of branch A . . . . . 196.
122. Vertical section of branch B . . . . . 196.
123. Vertical section of branch C, March 31 . . . . . 197.
124. Vertical section of branch E. March 31 . . . . . 197.
125. Piers of kamisch at the mouth of arm C . . . . . 198.
126. View towards S. 70° E. across the Kara-buran, as it was on 19 April 1896; between the bank to the left and the narrow kamisch-pier to the right is the river Tarim; beyond the pier is the lake . . . . . 199.
127. Formation of pier-like ramparts where the Tarim goes through the Kara-buran . . . . . 200.
128. Result of ramparts in the Kara-koschun . . . . . 201.
129. The volume of water in the Tarim during the course of the year . . . . . 206.
130. Distribution of land and water at Kona-abdal . . . . . 212.
131. Rampart between the Örtäng-köl and the Tarim . . . . . 212.
132. Formation of ramparts beside the Tarim . . . . . 213.
133. Vertical section of river and lakes . . . . . 214.
134. Basins of the Kara-koschun . . . . . 215.
135. View of Altmisch-bulak, the oasis at the foot of the Kuruk-tagh looking N E. 222.
136. Vertical section of schor . . . . . 223.
137. A 15 m. high clay eminence or highest storey of jardang . . . . . 224.
138. The jardang desert . . . . . 225.
139. Showing the highest kind of jardang . . . . . 226.
140. Old bed of the Tarim in the middle of the desert of Lop . . . . . 227.
141. Low jardangs . . . . . 228.
142. Part of a jardang surrounded by sand . . . . . 229.
143. Jardangs in the sand . . . . . 231.
144. Vertical section from S. to N. through the newly discovered oasis . . . . . 232.
145. Jardangs in the northern part of the desert, along the surveyed line . . . 236.
146. Jardangs in the central part of the desert upon the line of 1900 . . . . . 237.
147. Jardangs . . . . . 238.
148. Levelling the desert on the top of the jardangs . . . . . 239.
149. Some sand in the gullies between the jardangs . . . . . 240.
150. Old river-bed in the desert . . . . . 241.
151. Jardangs in the desert . . . . . 242.
152. Surface of the schor desert . . . . . 245.
153. A stake found in the schor desert . . . . . 249.
154. Poplar trunks in the schor desert . . . . . 250.
155. Dunes formed in the shelter of tamarisks . . . . . 251.
156. A solitary jardang in the sand . . . . . 314.
157. The Ilek at Kum-tscheke in 1896 . . . . . 330.
158. The Ilek at Ördek-jaghutsch, that is before entering the Avullu-kol . . . 332.
159. Effect of the Tarim upon the sandy desert . . . . . 336.
160. The Ilek at Ördek-jaghutsch; sand-dunes descending abruptly into the river on its eastern bank . . . . . 337.
161. Another view from the same place, showing an eddy of the river entering the sand on the eastern bank . . . . . 338.

Page.
Fig. 162. In *A* and *B* we have vertical sections from W. to E. through ordinary bajirs and dune accumulations in the region where the meridional Tarim now is situated. In *C* we have to the left (W.) the new-comer, the Ettek-tarim, and to the right (E.) the Ilek. In *D* the Ettek-tarim is dry, the sand accumulation is covering its old bed, the present Tarim is formed in the middle of the section, and to the right is still the Ilek with its western bank swept free from sand. The figure shows how the rivers have always made their courses in the existing chains of bajir-depressions . . . . . . . . . 340.
" 163. Vertical section of depressions . . . . . . . . . . . . . . . . . . . . . . 341.
» 164. The same . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 341.
» 165. Forest on the banks of the Ilek, below Kum-tscheke . . . . . . . . . . . . 342.
166. Vertical section of lakes . . . . . . . . . . . . . . . . . . . . . . . . 343.
» 167. East shore of Arka-köl. View looking south, showing sand-dunes proceeding towards the west across the lake; in the middle dead forest; to the right fresh vegetation on the very shore of the lake . . . . . . . . . . . . . 343.
» 168. Advancing dunes . . . . . . . . . . . . . . . . . . . . . . . . . . . . 344.
» 169. Part of Sadak-kol in 1896, showing a regular bajir-depression filled with water. The dead forest shows, that there was an early wet period followed by a dry period, which killed the toghraks. At the present time the depression is once more filled . . . . . . . . . . . . . . . . . . . . . . . . . . 346.
» 170. Nias-kol; a specimen of an old bajir-depression filled with water . . . . . . . 347.
» 171. Another view of the same . . . . . . . . . . . . . . . . . . . . . . . . 347.
» 172. Thick forest at Katak, Camp XIX, Kerija-darja, 1896 . . . . . . . . . . . . 350.
» 173. Sand-dunes bound by vegetation, at Kulatscha; Kerija-darja . . . . . . . . 351.
» 174. The migration of Lop-nor . . . . . . . . . . . . . . . . . . . . . . . . 364.
» 175. Jardangs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 364.
176. Vertical section of a jardang . . . . . . . . . . . . . . . . . . . . . . 365.
177. View of the Kuruk-tagh at Kalka; towards the NNW. The transverse valley of the Kontsche-darja coming down from Baghrasch-kol . . . . . . . . 393.
» 178—179. The dunes of Ak-bel-kum . . . . . . . . . . . . . . . . . . . . . 394.
» 180—182. Movements of dune-masses . . . . . . . . . . . . . . . . . . 401, 402.
» 183. The Masar of Ordan Padschah . . . . . . . . . . . . . . . . . . . . . . 406.
Relation between length and height, and angles of dunes in the western Takla-makan desert . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 409.
» 184—186. Dune- and wave-movements . . . . . . . . . . . . . . . . . 420, 421.
A sand-dune near Anau in Transcaspia . . . . . . . . . . . . . . . . . . . 425.
» 187. Ripple-marks on the crest of a dune. Desert of Lop . . . . . . . . . . . . 428.
» 188. Different patterns of ripple-marks. Desert of Lop . . . . . . . . . . . . . 429.
» 189—193. Movements of dune-masses . . . . . . . . . . . . . . . . . . 431—434.
194. A dune advancing with the same speed because the mass remains the same all the way . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 438.
» 195. A dune advancing slower as the mass increases . . . . . . . . . . . . . . 438.
» 196. A dune advancing quickly as its mass decreases . . . . . . . . . . . . . . 438.
A solitary toghrak north of the end of the Kerija-darja . . . . . . . . . . 440.
» 197. The valley of Tollan-chodscha on the upper road . . . . . . . . . . . . . 456.
» 198. Our caravan in the desert of Gobi . . . . . . . . . . . . . . . . . . . . 457.
» 199. Cylinders of sand . . . . . . . . . . . . . . . . . . . . . . . . . . . . 465.
» 200. A wind-worn stone, quartzitic sandstone. From the desert of Lop . . . . . 469.
» 201. Thick scrubby steppe north of Astin-tagh . . . . . . . . . . . . . . . . . 473.
» 202. First glimpse of the desert range . . . . . . . . . . . . . . . . . . . . . 474.
» 203. Parts of the desert range seen from the south . . . . . . . . . . . . . . . 475.
» 204. Vertical section of terrace . . . . . . . . . . . . . . . . . . . . . . . . 475.

Page
Fig. 205. Right side of the valley which opens out into the sandy desert . . . 478.
206. Another view of the same . . . 479.
207—209. Vertical sections of valley . . . 480, 481.
210. The depression with a ridge in the middle . . . 483.
211—213. Vertical sections of ground . . . 485, 486, 487.
214. Side-ravines opening through the clay hills . . . 488.
215. Profile through some clay hills . . . 488.
216. Clay hills running out into the desert . . . 489.
217. Effect of refraction . . . 490.
218. Vertical section of oasis . . . 491.
219—220. A kamisch-stalk . . . 492.
221. Vertical section of a little kamisch island in the desert . . . 492.
222. Jardangs . . . 493.
223. A view from the southern clay terrace partly covered with sand . . . 494.
224. The jardang-terrace . . . 494.
225. On the road to Toghrak-kuduk . . . 495.
226. Projecting part of the terrace not far from Toghrak-kuduk . . . 495.
227. The terrace looking east from Toghrak-kuduk . . . 496.
228—229. Terrace and sand-dunes . . . 497.
230. Another view of the clay terrace . . . 498.
231. My camp at Toghrak-kuduk . . . 498.
232. The last belt of vegetation on the road to Kuruk-tagh (see also Pl. 6 and 7) 499.
233—234. Vertical sections of desert . . . 500.
235. Kum-köl and Torpak-öldi as drawn by my cossak Tschernoff . . . 507.
236. Facsimile of another sheet made by Tschernoff . . . 508.
237. The bridgee at Korla where I measured the Kontsche-darja in 1896 . . . 518.
238. The ferry of Turfan-karaul. In the background the Kontsche-darja. To the right the station-house, 27 March 1896 . . . 519.
239. The Tschertschen-darja at Ak-ilek . . . 519.
240. Bank, with forest, of the Jarkent-darja . . . 531.
241. A view of the Ugen-darja in the neighbourhood of Dung-satma . . . 538.
242. Tscha-jan or Intschkä-darja at Tschong-tokaj . . . 539.
243. The Kuntschekisch-tarim at Kirtschin-kotan . . . 547.
244. The Turkomakte-kok-alasi . . . 549.
245. The Tarim at Schirge-tschapghan . . . 551.
246. A »köl« in the bed of lower Jangi-darja (Chotan-darja) May 27, 1895 . . . 566.
247. A water-pool in the dry bed of the Chotan-darja, end of May 1895 . . . 566.
248. The Jurun-kasch river, Camp I (1896), three days north of Chotan . . . 567.
249. The desert east of Chotan-darja . . . 568.
250. Dunes with tamarisks and kamisch east of Chotan-darja . . . 568.
251. Dunes between the Chotan-darja and the Kerija-darja . . . 568.
252. Kerija-darja at Camp XVII (1896) . . . 572.
253. Satma of Sarik-käschme, Kerija-darja, Camp XVIII . . . 572.
254. Kerija-darja Camp XX . . . 572.
255. Kerija-darja, Camp XXI, sharp-cut erosion-terrace . . . 573.
256. Desert at Camp XXII, north of Kerija-darja . . . 573.
257. View looking north from Camp XXII beside the lower Kerija-darja (1896) . . . 573.
258. Dunes with saksaul. Camp XXIX (1896) between Kerija-darja and Tarim . . . 574.
259. A solitary toghrak in the desert north of Kerija-darja, Camp XXVII . . . 574.
260. Vertical section . . . 580.
261. Dunes forming into mounds, eastern shore of Tajek-köl; in the middle is a salt pool . . . 581.

Page.
Fig. 262. Men (Tschimen) . . . . . . . . . 600.
263. Women (Abdal) . . . . . . . . . 601.
264. Children (Lajlik) . . . . . . . . . 602.
265. A lopman in a canoe . . . . . . . . . 603.
266. Satmas in Kum-tscheke . . . . . . . . . 603.
267. The house of the Bek in old Tikenlik . . . . . . . . . 604.
268. Entrance to the bazaar of Tavek-kel . . . . . . . . . 605.
269. Gate of Kara-schahr . . . . . . . . . 606.
270. A view from Tscharklik . . . . . . . . . 607.
271. A view from Tscharklik . . . . . . . . . 609.
272. Mosque and market place in Ak-su . . . . . . . . . 610.
273. Tschihil-ten, cemetery of Jarkent . . . . . . . . . 612.
274. The ghuristan or burial-place of Tschigelik-uj . . . . . . . . . 612.
275. Tadschik musicians, Taghdumbasch Pamir . . . . . . . . . 613.
276. Three girls . . . . . . . . . 615.
277. Ruined tower found on March 28 . . . . . . . . . 619.
278. Another view of the same . . . . . . . . . 620.
279. Our Camp of March 28 . . . . . . . . . 621.
280. View of the big house . . . . . . . . . 622.
281—284. Views from Loù-lan . . . . . . . . . 622—625.
285. View of ruined houses March 28 . . . . . . . . . 626.
286. Earthenware vessels . . . . . . . . . 627.
287. Clay vessels with ornamentation . . . . . . . . . 629.
288. Sheaves of kamisch bound to a horizontal pole . . . . . . . . . 630.
289. Fragments of wood-ornamentation . . . . . . . . . 630.
290. Specimens of fish-bones from Loù-lan . . . . . . . . . 633.
291. How the jar was carried . . . . . . . . . 634.
292. Vertical section of tower . . . . . . . . . 639.
293. Wood-carvings from house B . . . . . . . . . 642.
294. The same . . . . . . . . . 643.
295. The same . . . . . . . . . 644.
296. Jardangs and sand-dunes . . . . . . . . . 646.
297. Vertical section of the same from NNE. to SSW. . . . . . . . . . 646.

# MAPS AND SECTIONS.

Page

Pl. 1. Views of Budschentu-bulak and Kurbantschik . . . . . . . . . . . . . . . 25.

2 The Kuruk-darja at Jing-pen . . . . . . . . . . . . . . . . . . 37.

5. The Mountain-systems of Tschol-tagh and Kuruk-tagh . . . . . . . . . . 101.

18. The branches from Kara-koschun to the newly discovered lake in the Desert of Lop 195.

23. 1) Altmisch-bulak; 2) The new desert lakes as described by my servant Fajsullah 235.

31 + 33. Wegener and Himly: Nord-Tibet und Lob-nur Gebiet . . . . . . . . . 283.

32. Chinese map. reproduced from Petermanns Mitteilungen . . . . . . . . . . 285.

34. A reconciliation of the Wu tschang-fu map with the real geographical data . . 293.

35. 1) The lowest Tarim and the Kara-koschun as surveyed by different travellers;
2) Kosloff's views as to the situation of Kum-darja and old Lop-nor . . 295.

36. The measured line through the Desert of Lop . . . . . . . . . . . . 325.

37. Profile of the measured line through the Desert of Lop . . . . . . . . . . 327.

38. Some important Hydrographical and Hypsometrical Lines in the Tarim Basin . . 341.

38 a. Positions of the rivers and lakes relatively to the bajir depressions . . . 341.

39. Distribution of Desert and Vegetation in the Lop Region . . . . . . . . 343.

40. The pendulum-like oscillations of the terminal lake of the Tarim system . . . . 363.

41. Lake-currents etc. in the Lop Region . . . . . . . . . . . . . . . . . 367.

42. The Kara-kol Lakes. 1896 . . . . . . . . . . 369.

44 a. Desert, steppe and forest in the Tarim Basin . . . . . . . . 399.

44 b. Deserts in Asia and Africa . . . . . . . . . . . . . . . . . . 399.

51. Transportation of disintegration products in the eastern part of the Tarim Basin 459.

57. Catchment-areas of the streams draining into the East Turkestan Basin . 523.

58. Hypsometrical curves of the Tarim Basin . . . 563.

59. Hypsometrical curves in the Desert of Tschertschen and Lop . . . . 575.

60. Some vertical sections . . . . . . . . . . 579.

61. Hypsometrical curves in the Desert of Lop . . . . . . . 579.

61 a. Hypsometrical curves of a part of the levelled line . 579.

61 b. Some vertical sections . . . . . . . . 579.

61 c. Vertical section of the Tarim river . . . . . . 595.

63. Distribution of the Population of East Turkestan 613.

67. Ruins of Loû-lan . . . . . . . . 631.

75. The northwesternmost village at Loû-lan . . . . . . 645.

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